
Autodesk® FeatureCAM® 2018

Getting Started



Contents

Getting started in FeatureCAM 1

Starting FeatureCAM for the first time.....	2
Creating a new file	4
FeatureCAM interface.....	4

Introduction to 2.5D milling 6

Defining the Stock.....	6
Creating the features	7
Viewing the part	9
Simulating the toolpaths.....	9
Order of manufacturing operations	11
Automatic ordering options.....	12
Manual ordering options	13
Part documentation (2.5D milling).....	15
Controlling the strategies	15
Generating NC code	16
Tool mapping	17
Changing the post processor	17
Saving the NC code	17

Introduction to turning 19

Defining the stock	19
Preparatory steps	20
Defining the geometry.....	21
Creating the features	23
Viewing the part	27
Simulating the toolpaths.....	29
Order of manufacturing operations	30
Part documentation (Turning)	32
Generating NC code (Turning).....	33
Changing the post processor	33
Saving the NC code	33

Introduction to turn/mill 34

Preparatory steps	35
Defining the geometry.....	35
Creating the features	37
Viewing the part	38

Creating three radial holes on the face	39
Engraving the face	41
Creating three slots.....	43
Simulating the toolpaths.....	44
Introduction to 3D milling	45
Defining the Stock.....	46
Defining the geometry.....	46
Creating the bottle surface.....	50
Viewing the part	51
Creating a surface milling feature	53
Simulating the toolpaths.....	54
Introduction to wire EDM	55
Defining the stock	55
Creating the profile	56
Creating a wire EDM feature.....	56
Simulating the wire EDM toolpath	57
Generating NC code	59
Adding a taper angle.....	60
Introduction to Feature Recognition	63
Automatic Feature Recognition example	64
Importing the solid model	65
Using Automatic Feature Recognition	67
Simulating the toolpaths (AFR).....	69
Interactive Feature Recognition example.....	70
Importing the solid model	71
Using Interactive Feature Recognition	73
Tool selection (IFR)	76
Simulating the toolpaths (IFR)	78
Autodesk Legal Notice	79
Index	95

Getting started in FeatureCAM

FeatureCAM is a CAD/CAM software suite that automates machining and minimizes programming times for parts on mills, lathes, and wire EDM.



The functionality available to you is license dependent.

FeatureCAM generates toolpaths based on the features of the part, and automatically selects appropriate tools, determines roughing and finishing passes, and calculates feeds and speeds.

This **Getting Started** guide provides step-by-step instructions that highlight some of the features of this versatile software.

FeatureCAM is easy to use, and does not require specialist computing knowledge.

Starting FeatureCAM for the first time

- 1 From the **Start** menu, select **All Programs > Autodesk > FeatureCAM**.



You can also start the program by double-clicking the



FeatureCAM icon on your desktop.

The first time you start FeatureCAM, it runs a program to create the tools and materials database.

- 2 Click **OK** to begin the configuration. This displays the **Tool and Material Setup** dialog.

- 3 To create a local database, select **On my local computer**.

If you want multiple computers to share the same tool and material information:

- a Select **On another computer that I will access over a network**.
- b Click the **Browse** button, and use the **Database Location** dialog to select the folder where the database is located.



You need to create a database folder on your network first, and then copy an empty MDB database from the FeatureCAM CD-ROM to this location. The default database is created by MS Access, and should be accessed using the MS Jet database driver. You may use a different database type, such as MS SQL Server. For more information, refer to the online help.

- 4 Click **Next**.

- 5 Choose the tools to load:

Inch - loads only the inch tools.

Metric - loads only the metric tools.

Both - loads both inch and metric tools.

- 6 Click **Next**.

- 7 If you chose to load both tool types, you are asked which tool type you use more often. Select **Inch** or **Metric**, and click **Next**.

- 8 Click **Finish** to initialize the database.



*The tools database specifies the set of tools used by FeatureCAM to perform manufacturing operations. For best results, use the **Tool Manager** (available from the **Manufacturing** menu) to customize the database to reflect the tools in your shop.*

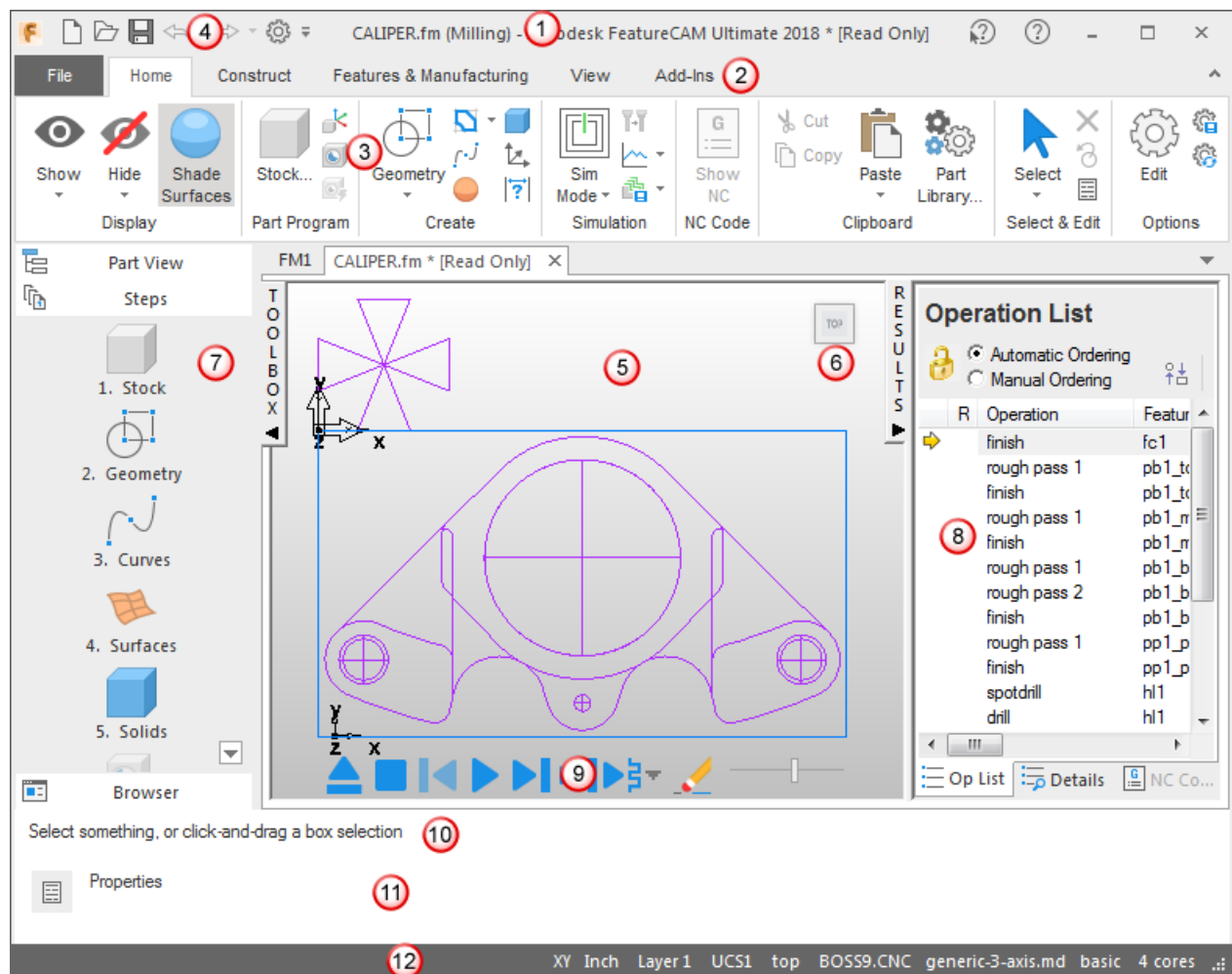
Creating a new file

To create a new file:

- 1 Start FeatureCAM, and close any open documents.
- 2 In the **Available Document Types** list, select the kind of part file you want to create.
- 3 Select the **Unit of Measure** (Inch or Millimeter).
- 4 Click **Create New Document**.
The Stock wizard is displayed.
- 5 Click **Finish** to close the Stock wizard.

FeatureCAM interface

The FeatureCAM interface contains a number of traditional Windows elements, such as a ribbon, dialogs, context menus, and wizards.



1 Title bar

- ② Ribbon tabs
- ③ Ribbon commands, grouped into panels
- ④ Quick Access Toolbar
- ⑤ Graphics window
- ⑥ ViewCube
- ⑦ **Toolbox** window with **Part View**, **Steps** panel, and **Browser**.
- ⑧ **Results** window
- ⑨ Simulation toolbar
- ⑩ **Assistance** bar
- ⑪ **Feature/Geometry Edit** bar
- ⑫ Status bar

The **Title** bar displays the name of your part file, in this case **CALIPER.fm**, and the type of part setup in round brackets, in this case **(Milling)**. When you have any unsaved changes in your part file, an asterisk (*) is displayed next to its name.

Right-clicking displays a context menu. The menu varies depending on where you are in the program. The menu contains common commands and functions that are useful in that area.

Introduction to 2.5D milling

This example shows you how to create some simple 2.5D features, generate toolpaths and output the toolpaths used to machine the part.

To use the 2.5D milling example, start FeatureCAM (see page 2), create a new file (see page 4), then follow these steps:

- 1 Create the stock (see page 6).
- 2 Create the features (see page 7).
- 3 View the part (see page 9).
- 4 Simulate the toolpaths (see page 9).
- 5 Create the part documentation (see page 15).
- 6 Control the automation (see page 15).
- 7 Change the post processor (see page 17).
- 8 Generate NC code (see page 16).
- 9 Tool mapping (see page 17).
- 10 Save the NC code (see page 17).

Defining the Stock

The stock is the initial material from which you cut your part. When you create a new part, the **Dimensions** page of the **Stock** wizard is displayed. It enables you to determine the shape and dimensions for the stock, the stock material, part program zero, and the coordinate system for modeling.

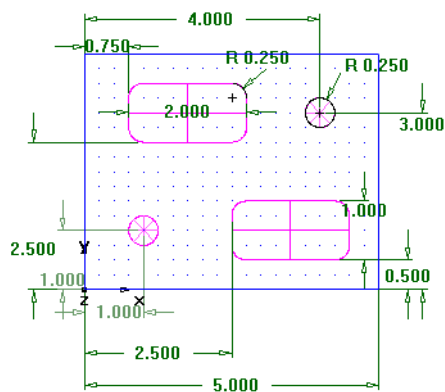
- 1 On the **Dimensions** page of the **Stock** wizard:
 - a Enter a **Width** of **4** (**100** mm).

- b** Enter a **Length** of **5** (125 mm).
 - c** Enter a **Thickness** of **1** (25 mm).
 - d** Click **Finish**.
- 2** Click **OK** to accept the default values of the **Stock Properties** dialog.

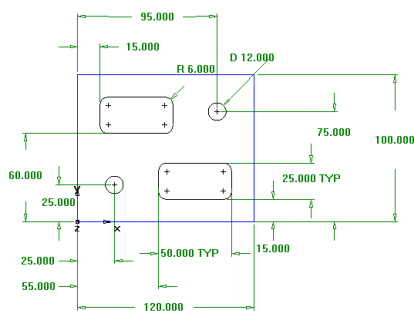
Creating the features

This step shows how to create Hole and Rectangular Pocket features.

Inches:



Millimeters:



- 1** Create a Hole feature.

- a** Click the **Features**  step in the **Steps** panel.
- b** In the **New Feature** wizard, select **Hole** in the **From Dimensions** section, and click **Next**.
- c** Enter a **Diameter** of **0.5** (12 mm), and click **Next**.
- d** Enter a hole center location of **X 1.0** (25 mm) and **Y 1.0** (25 mm), and click **Next**.

This displays the **Strategies** page. This page controls the types of operations used to cut the feature. The default operations for a Hole feature are to spot drill and then drill the hole. If the Hole has a chamfer, the default is to cut the chamfer with the spot drill operation.

- e Accept the default strategy settings by clicking **Next**.

The **Operations** page shows a summary of the operations to cut the feature, the automatically selected tools, and the feeds and speeds.

- f From the **Finish** menu button select the **Finish** option.

2 Create a Rectangular Pocket feature.

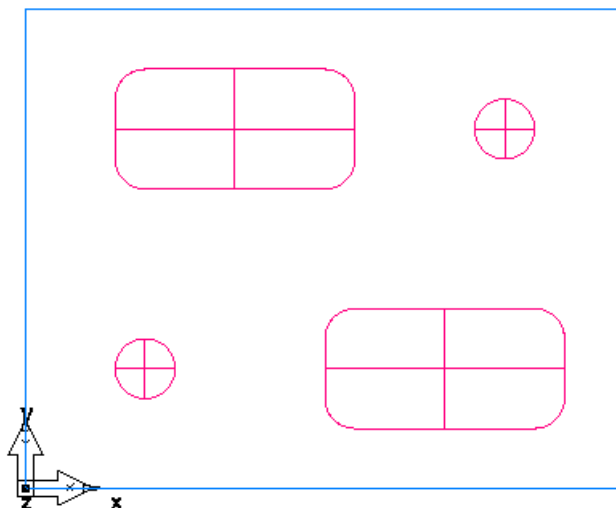
- a Click the **Features**  step in the **Steps** panel.
- b In the **New Feature** wizard, in the **From Dimensions** section, select **Rectangular Pocket**, and click **Next**.
- c Accept the default dimensions by clicking **Next**.
- d Enter a pocket location of **X 0.75 (15 mm)**, and **Y 2.5 (60 mm)**, and **Z 0 (0 mm)**, and click **Next**.

The **Strategies** page shows that roughing and finishing operations are created.

- e Click the **Finish** button.

3 Use the **Features** step to create a second Hole with a diameter of **0.5 (12 mm)**, located at **X=4 (95 mm)** and **Y=3 (75 mm)**.

4 Use the **Features** step to create another Rectangular Pocket the same dimensions as the first, but positioned at **X=2.5 (55 mm)**, **Y=0.5 (15 mm)**.

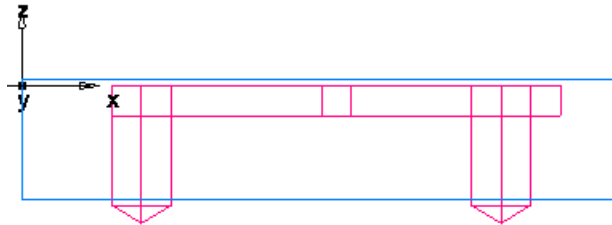


- 5 Select **File > Save**, and save the part as **milling.fm**.

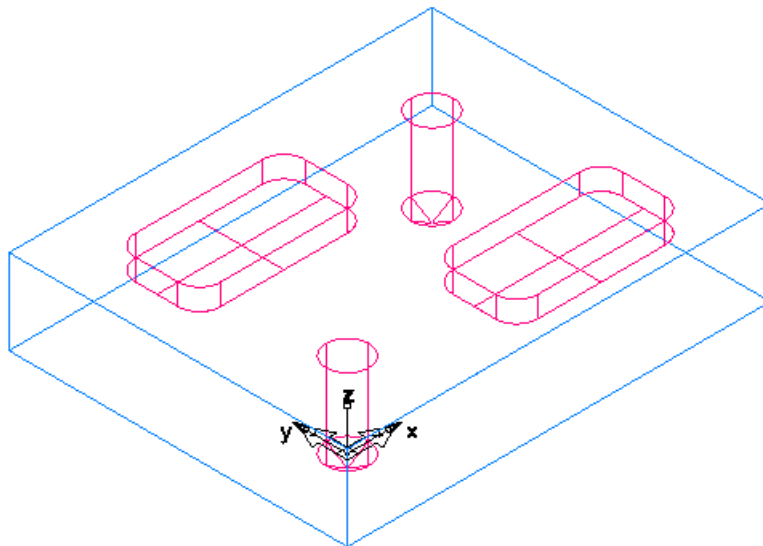
Viewing the part

To look at the part in a different orientation you can select one of the standard predefined views.

- 1 To change the view to a front view, click **View tab > Views panel > Principal Views > Front**.



- 2 To change to an isometric view, click **View tab > Views panel > Isometric Views**.



Simulating the toolpaths

Now you have created the features, FeatureCAM automatically:

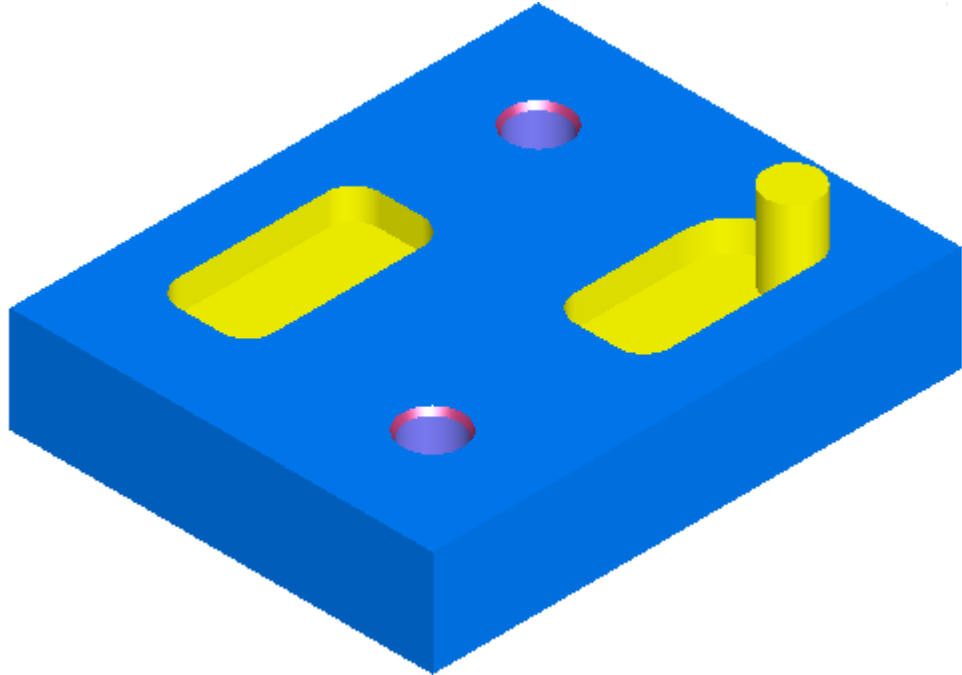
- Selects the most appropriate tools and operations;
- Recommends machining strategies;
- Calculates speeds and feeds;
- Generates toolpaths and creates the NC code.

To view the simulated toolpath:

- 1 Click **Home tab > Simulation panel > Sim Mode > 3D** to change the simulation type.

- 2 Click **Play**  on the Simulation toolbar to start the simulation. If the **Automatic Ordering Options** dialog displays, click **OK** to close it.

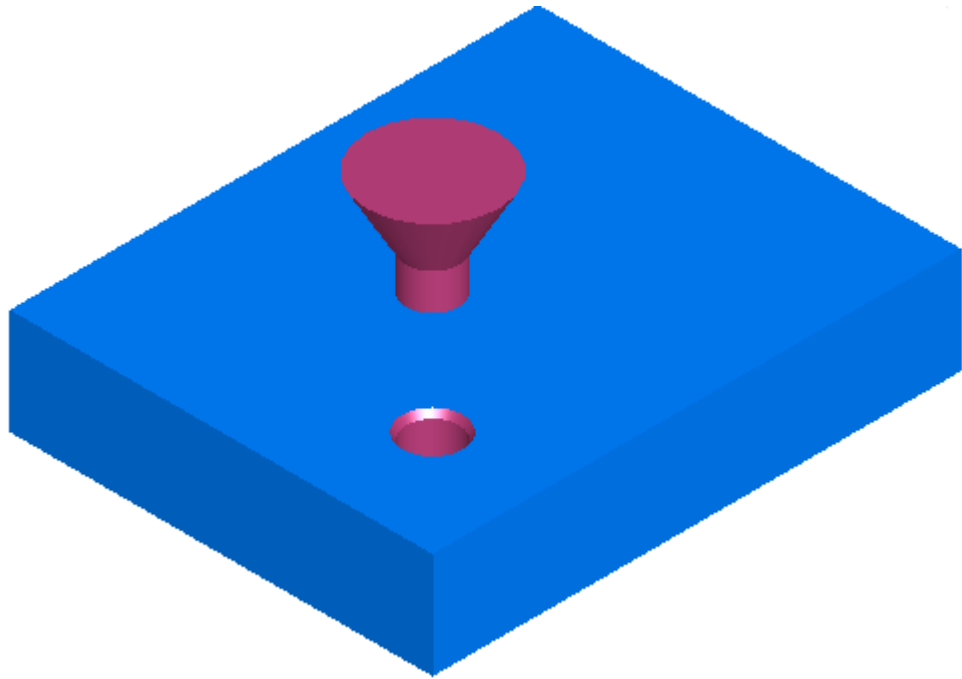
This displays a solid 3D rendering of the cutting process.



*If all tools are displayed in gray in the simulation, enable the **File > Options > Simulation tab > Tool Colors** option to see which features are machined by each tool.*

*Click **Play**  on the Simulation toolbar to see the changes.*

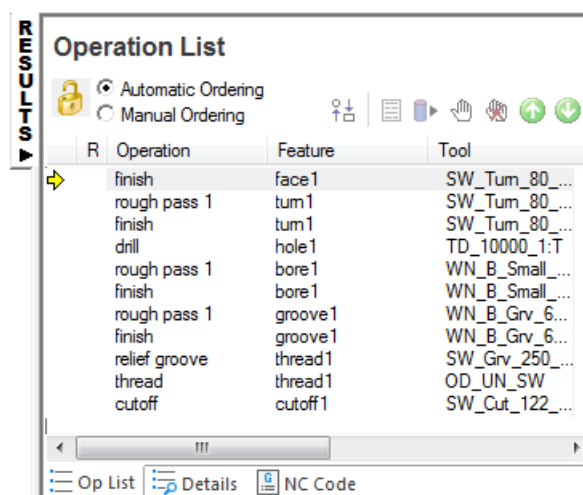
- Click **Play to Next Operation** . This displays the spot drill operation.



- Click **Play to Next Operation**  again to view each subsequent operation until you complete the simulation.
- Click **Eject**  to end the simulation.

Order of manufacturing operations

The **Op List** tab in the **Results** window shows all of the operations needed to machine the features. A yellow warning  sign next to an operation indicates a potential problem with that operation. In this case, if you see any warnings ignore them.



This section looks at:

- The automatic ordering options. (see page 12)
- The manual ordering options. (see page 13)

Automatic ordering options

You can control the automatic ordering of operations by using either rules or operation templates. The turning tutorial looks at operation templates.

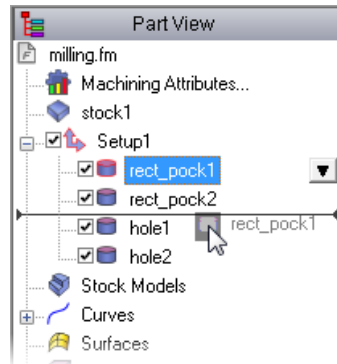
- 1 Select the **Automatic Ordering** option on the **Op List** tab. This ensures the automatic ordering rules are applied to the operations.
- 2 Change the automatic ordering to group together the operations which use the same tool.
 - a Click the **Ordering ordering options**  button.
 - b In the **Automatic Ordering Options** dialog, select **Minimize tool changes**, deselect everything else, and click **OK**.
- 3 Simulate the part.
 - a Click Home tab > Simulation panel > Sim mode > 3D to change the simulation type.
 - b Click **Play**  on the Simulation toolbar to start the simulation.

Notice that the simulation first performs all the spot-drills, then the drills, and then the rough and finish milling for the pockets.
 - c Click **Eject**  to end the simulation.
- 4 Change the automatic ordering to move the finish operations to the end of the list.
 - a Click the **Ordering ordering options**  button.
 - b In the **Automatic Ordering Options** dialog, select **Do finish cuts last**, deselect everything else, and click **OK**.

This changes the order of operations in the **Operation List**.
- 5 Simulate the part.
 - a Click **Play**  on the Simulation toolbar to start the simulation.

The finish cuts for the two pockets are now cut last.
 - b Click **Eject**  to end the simulation.
- 6 Change the automatic ordering to match the order of the features in the **Part View** panel.

- a Click the **Ordering Options**  button.
- b Deselect everything, and click **OK**.
- c Open the **Part View** panel by clicking **Part View** on the left of the Graphics window. The tree view contains all the setups and features you have created.
- d Click the **rect_pock2** item in the **Setup1** node, and drag it up above **hole2**.



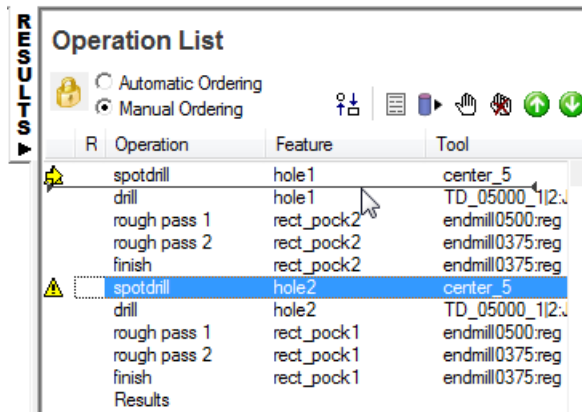
- 7 Simulate the part.
 - a Click **Play**  on the Simulation toolbar
The second pocket is cut as the second feature.
 - b Click **Eject**  to end the simulation.

Manual ordering options

The automatic ordering of operations determined the order by a set of rules. You can also specify an exact ordering of operations manually.

- 1 Select the **Manual Ordering** option on the **Op List** tab.
- 2 In the **Fixed Operation Ordering** dialog, select **Do Not Show This Warning Again**, and click **OK**.

- 3 Select the **spotdrill** operation for **hole2** from the list, and drag it up ahead of the **drill** operation for **hole1**.

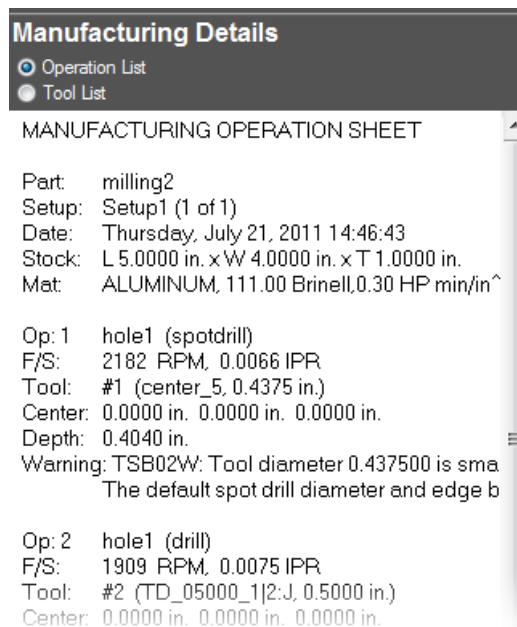


- 4 Simulate the part.
- a In the **Simulation** toolbar, click **Play** . The simulation performs the operations in the new order.
 - b Click **Eject**  to end the simulation.
- 5 Selecting **Automatic Ordering** to return to automatic ordering.
- 6 Click **OK** to close the **Automatic Operation Ordering** dialog.

Part documentation (2.5D milling)

As well as simulating the part manufacture, the simulation generates tool and operation lists. The tools selected are based on your tool database. You can print this information to use as an operator's checklist by clicking **File > Print** and selecting **Operations List**.

- 1 Click the **Details** tab in the **Results** window to display the Manufacturing Operation sheet.



- 2 Select the **Tool List** option at the top of the **Details** tab to show the Manufacturing Tool Detail sheet. It contains all of the tools used to create the part based on the tool crib you selected.

Controlling the strategies

You can control the strategies used to manufacture the part from the properties dialog.

- 1 Open the **Part View** panel.
- 2 Right-click on **hole1** under the **Setup1** node, and select the **Properties** option.
- 3 In the **Properties** dialog:
 - a Select the **Strategy** tab
 - b Deselect the **Spot Drill** option
 - c Click **OK**.

- 4 Click Home tab > Simulation panel > Sim mode > 3D to change the simulation type.
- 5 Click **Play**  on the Simulation toolbar to start the simulation.

There is no spot drilling for the first hole. If you look through the operations list, there is only one **spotdrill** operation listed. FeatureCAM optimizes the part manufacturing process, but you control the level of automatic optimization.
- 6 Click **Eject**  to end the simulation.

Generating NC code

FeatureCAM generates the NC code to manufacture parts on a CNC machine. You can generate NC code after you have simulated the part, and therefore calculated the toolpaths.

- 1 Select the **NC Code**  step from the **Steps** panel. This displays the **NC Code** dialog.
- 2 Click **Display the NC code in the results window**.

Tool mapping

To change the location of the tools in the tool changer:

- 1 Select the **NC Code**  step from the **Steps** panel. This displays the **NC Code** dialog.

Click **Re-map the tools**. This displays the **Tool Mapping** dialog showing the current tool order.

- 1 To move the center drill to the 5th position in the tool changer:
 - a Select **Center_5** in the table.
 - b Enter a **Tool Number** of **5** in the **Slots** frame.
 - c Click **Set**.



You cannot change the number in the table.

- 2 Click **OK** to save the changes, and close the **Tool Mapping** dialog.

Changing the post processor

To change the post processor:

- 1 Click the **Customize Mfg.** step in the **Steps** panel.
- 2 Click **Configure postprocessor**.
- 3 Click **Browse** to view available post processors.

The default folder for posts is [..\Examples\Posts](#).

- 4 Select your post processor and click **Open**.

The new post processor is displayed in the **CNC File** field.

- 5 Click **OK** to close the dialog.
- 6 Run a simulation of the part to regenerate the NC code.

Saving the NC code

To save an NC program:

- 1 Select the **NC Code**  step from the **Steps** panel. This displays the **NC Code** dialog.
- 2 Click **Save the NC code**.
- 3 In the **Save NC** dialog, accept the default filename and folder, and click **OK**.

Introduction to turning

This tutorial shows you how to create a simple turning part, generate toolpaths and output the toolpaths used to machine the part.

To use the turning example, start FeatureCAM (see page 2), create a new file (see page 4) with a **Type of Turn/Mill Setup or Turning Setup**, then follow these steps:

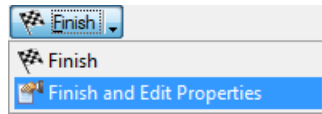
- 1 Create the stock (see page 19).
- 2 Preparatory steps (see page 20).
- 3 Define the geometry (see page 21).
- 4 Create the features (see page 23).
- 5 View the part (see page 27).
- 6 Simulate the toolpaths (see page 29).
- 7 Order the manufacturing operations (see page 30).
- 8 Create part documentation (see page 32).
- 9 Change the post processor (see page 17).
- 10 Generate NC code (see page 33).
- 11 Save the NC code (see page 17).

Defining the stock

The stock is the initial material from which you cut your part. By default, the **Stock** wizard (**Dimensions** page) opens on the screen as soon as you create a new part. It enables you to set the shape and dimensions for the stock, the stock material, part program zero, and the coordinate system for modeling.

- 1 On the **Dimensions** page of the **Stock** wizard:
 - a Enter an **OD** (outside diameter) of **4** (**100** mm).

- b** Enter a **Length** of **5** (125 mm).
- c** Enter an **ID** (inside diameter) of **0** (0 mm).
- d** From the **Finish** menu button select the **Finish and Edit Properties** option.



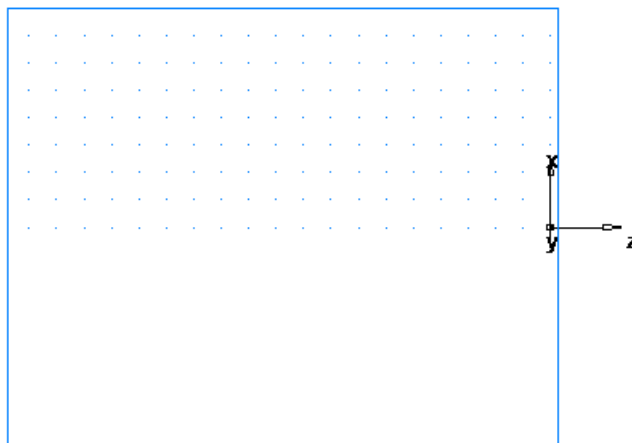
This displays the **Stock Properties** dialog.

- 2** In the **Stock Properties** dialog enter a **Z** of **0.0625** (1.5 mm), and click **OK**.

Preparatory steps

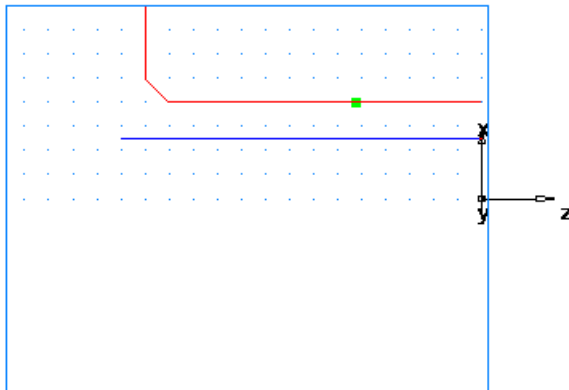
The preparatory steps determine the coordinate system and tool crib.

- 1** Click **File > Options > General > Dialogs**, and under **Turning Diameter** select **3D (XYZ)** to enable you to enter coordinates as **X**, **Y**, and **Z** values.
- 2** Click **Features & Manufacturing tab > Tools panel > Tool Crib** to display the **Select Active Tool Crib** dialog.
- 3** Select the **tools** option from the **Crib List**, and click **OK**.
- 4** Click **View tab > Navigate panel > Resize > Resize to fit** to display the complete part.



Defining the geometry

This shows you how to design your part.



1 Draw two lines:

- a Click Construct tab > Geometry panel > Line menu > 2 Points.
- b The Feature/Geometry Edit bar is displayed.

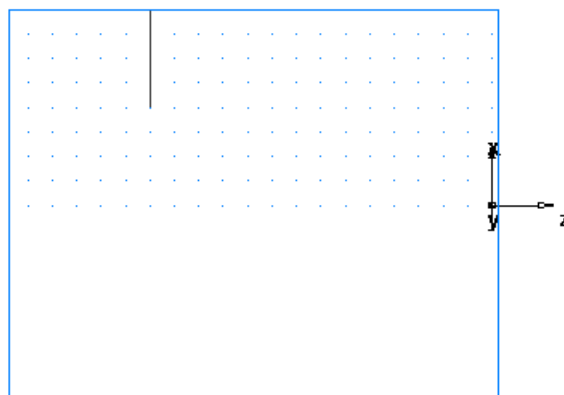
D/Z 1	0.0000	0.0000	0.0000	D/Z 2	0.0000	0.0000	0.0000	A	45	L	1.0000	Create
												Options

c In the Feature/Geometry Edit bar:

For point 1, enter an XYZ 1 of X **2** (50 mm), Y **0**, Z **-3.5** (-88 mm).

For point 2, enter an XYZ 2 of X **1** (25 mm), Y **0**, Z **-3.5** (-88 mm).

Press **Enter**. This draws a line in the graphics window.

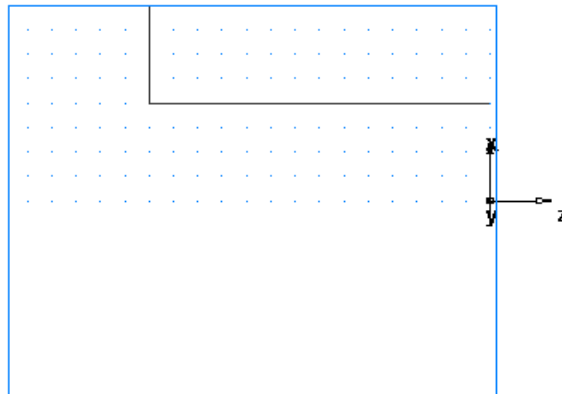


d Create a second line:

For point 1 enter an XYZ 1 of X **1** (25 mm), Y **0**, Z **-3.5** (-88 mm).

For point 2 enter an XYZ 2 of X **1** (25 mm), Y **0**, Z **0**.

Press **Enter** to create a second line.



2 Create a chamfer to trim your lines.

a Click Construct tab > Geometry panel > Fillet menu > Chamfer.

b In the Feature/Geometry Edit bar, enter:

A width of **0.25** (6 mm).

A height of **0.25** (6 mm).

c Position your mouse pointer close to the chamfer location. The chamfer snaps into place.



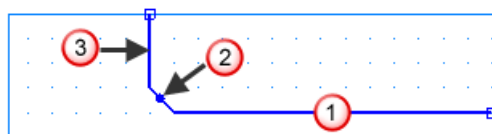
d Click to place the chamfer on your drawing. The chamfer automatically trims your lines.

3 To turn the part you need to convert these three individual lines into a single curve (chain the curve).

a Select the **Curves**  step from the **Steps** panel.

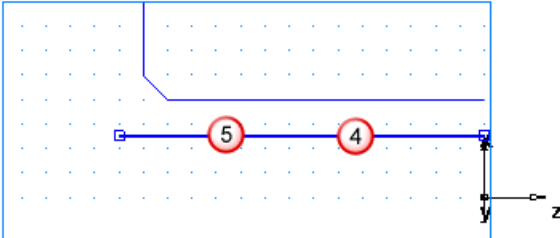
b In the **Curves Creation** dialog, select **Chain pieces of geometry into an open boundary** using a mouse click at each end.

c In the graphics window, click locations **1**, **2**, and **3**. Each line segment changes color when selected.



d In the Feature/Geometry Edit bar, name the curve **turn**, and press **Enter**.

4 Create third line which you will use to create a Bore feature.

- a Click Construct tab > Geometry panel > Line menu > 2 Points.
 - b In the Feature/Geometry Edit bar:
For point 1 enter an XYZ 1 of X **0.625** (16 mm), Y **0**, Z **0**.
For point 2 enter an XYZ 2 of X **0.625** (16 mm), Y **0**, Z **-3.75** (-94 mm).
 - c Press **Enter**.
- 5 To chain the bore curve:
- a Select the **Curves**  step from the **Steps** panel.
 - b In the **Curves Creation** dialog, select **Chain pieces of geometry into an open boundary using a mouse click at each end**.
 - c In the graphics window, click locations 4 and 5 (you select the same line twice).
- 
- d In the Feature/Geometry Edit bar, name the curve **bore**, and press **Enter**.

Creating the features

This shows you how to create the turning features.

- 1 Select View tab > Appearance panel > Line Display menu > Turning 2D View to switch to a simplified 2D representation of the part.
- 2 Create a Turn feature.
 - a Click the **Features**  step in the **Steps** panel.
 - b In Turn/Mill documents, the **New Feature** wizard asks you which type of feature you want to create. Select the **Turning** option, and click **Next**.
 - c Select **Turn** in the **From Curve** section, and click **Next**.
 - d In the **Curve** field select **turn** from the list.

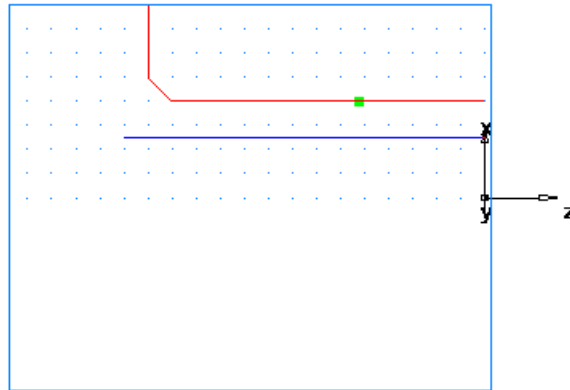
Click the **Pick Curve**  button to select the curve graphically. The dialog minimizes to reveal the graphics window beneath.

Click the curve you named **turn** earlier.

In this case, two objects are available for selection: a line and a curve. Whenever your selection must be clarified, FeatureCAM opens the **Select** dialog.

In the **Select** dialog, select **turn**, and click **OK**.

- e From the **Finish** menu button, select the **Finish and Create More** option to continue creating features.



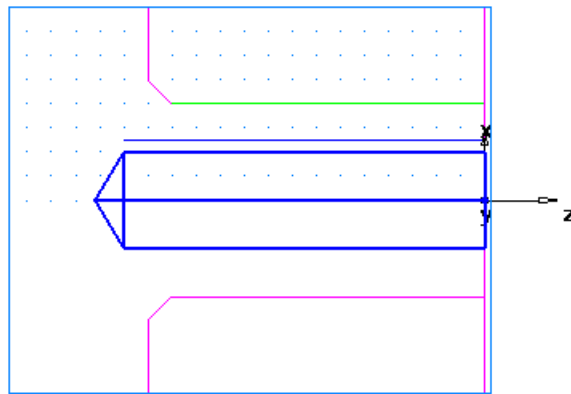
3 Create a Face feature.

- a In the **New Feature** wizard, select the **Turning** option, and click **Next**.
- b In the **From Dimensions** frame, select **Face**, and click **Next**.
- c On the **Dimensions** page:
 - Enter a **Thickness** of **0.0625** (**1.5** mm).
 - Enter an **Outer Diameter** of **4** (**100** mm).
 - Enter an **Inner Diameter** of **0**.
 - Click **Next**.
- d Click **Finish and Create More**.

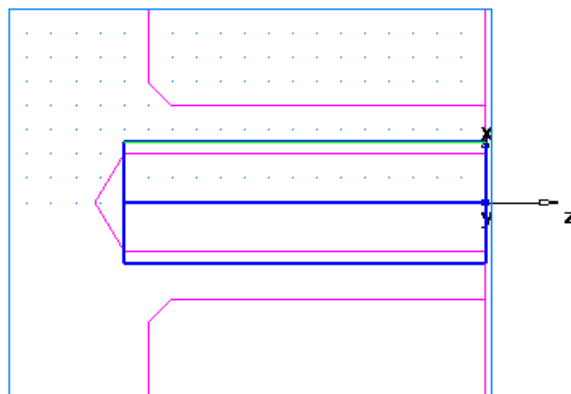
4 Create a Hole feature.

- a In the **New Feature** wizard, select the **Turning** option, and click **Next**.
- b In the **From Dimensions** frame, select **Hole**, and click **Next**.
- c On the **Dimensions** page:
 - Enter a **Depth** of **3.75** (**94** mm).
 - Enter a **Diameter** of **1.0** (**24** mm).
 - Click **Next**.
- d On the **Location** page enter a **Z** of **0**.

- e Click **Finish and Create More**.

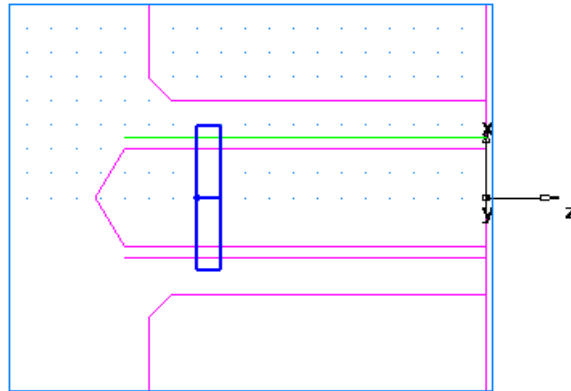


- 5 Create a Bore feature by using the same process you used to create the Turn feature. Use the curve named **Bore**.



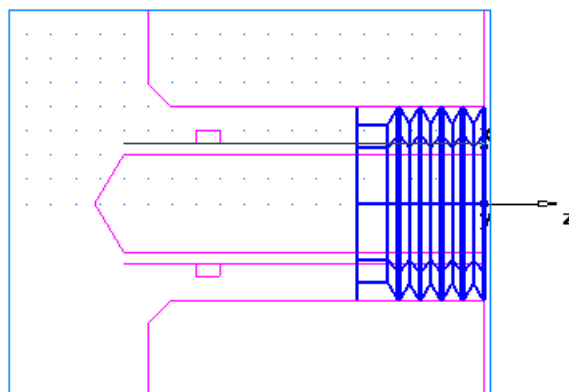
- 6 Create a Groove feature.
- a In the **New Feature** wizard, select the **Turning** option, and click **Next**.
 - b In the **From Dimensions** frame select **Groove**, and click **Next**.
 - c On the **Dimensions** page:
 - Select a **Location** of **ID**.
 - Select an **Orientation** of **X axis**.
 - Enter a **Diameter** of **1.25** (**31** mm).
 - Enter a **Depth** of **0.125** (**3** mm).
 - Enter a **Width** of **0.25** (**6** mm).
 - Leave the other settings at **0**.
 - Click **Next**.
 - d On the **Location** page enter a **Z** of **-3** (**-75** mm).

- e Click **Finish and Create More**.



7 Create a Thread feature.

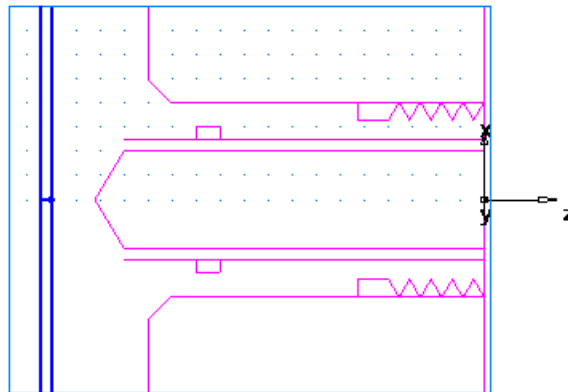
- a In the **New Feature** wizard, select the **Turning** option, and click **Next**.
- b In the **From Dimensions** frame, select **Thread**, and click **Next**.
- c On the **Dimension** page:
Select **Get the thread dimensions from a standard thread**.
Select **OD**.
In the **Designation** field select the **2.0000- 4.5 UNC** (**M50-15** for metric).
Click **Next**.
- d On the **Dimensions** page:
Select a **Thread of Right hand**.
Enter a **Thread Length** of **1.0** (**24 mm**).
Click **Next**.
- e Click **Finish and Create More**.



8 Create a Cutoff feature.

- a In the **New Feature** wizard, select the **Turning** option, and click **Next**.

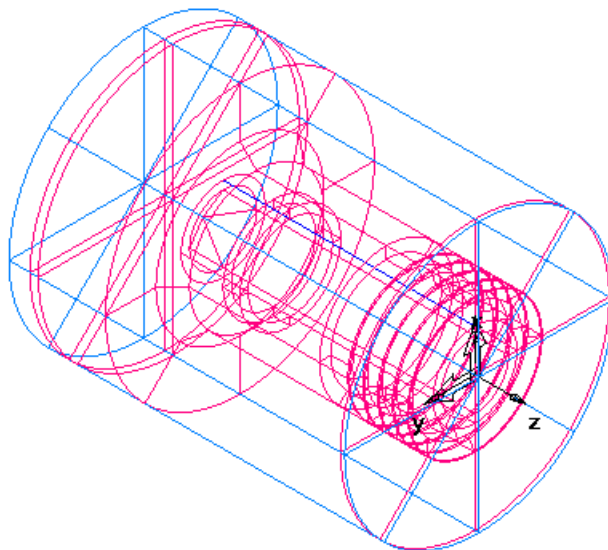
- b** In the **From Dimensions** frame select **Cutoff**, and click **Next**.
- c** On the **Dimensions** page:
 - Enter a **Diameter** of **4** (**100** mm).
 - Enter an **Inner Diameter** of **0**.
 - Enter a **Width** of **0.122** (**3** mm).
 - Click **Next**.
- d** On the **Location** page enter a **Z** of **-4.5** (**-112** mm).
- e** Click **Finish**.



Viewing the part

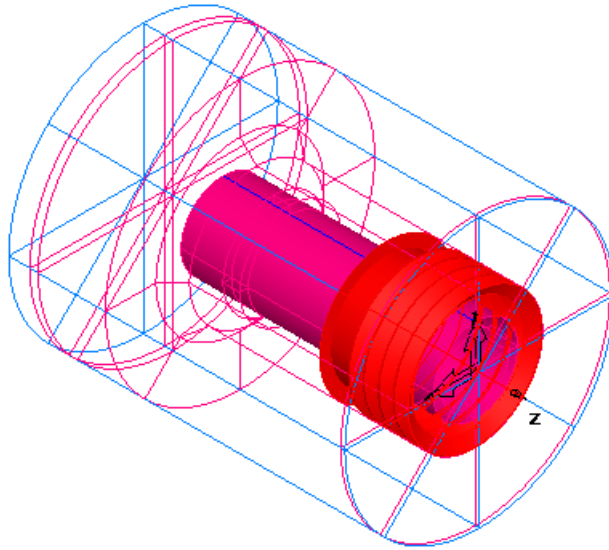
You have been working in a 2D view.

- 1** Deselect View tab > Appearance panel > Line Display menu > Turning 2D View to return to a 3D view of the model.
- 2** Click View tab > Views panel > Isometric Views menu > Isometric.



- 3** Shade the part.

- a Open the **Part View** panel, and select **bore1** under the **Setup1** node.
- b Select View tab > Appearance panel > Shading menu > Shade Selected.
- c Select **thread1** in the **Part View** panel.
- d Select View tab > Appearance panel > Shading menu > Shade Selected.



- 4 Select View tab > Appearance panel > Shading menu > Unshade All to return to the wireframe view of the part.

Simulating the toolpaths

Now you have created the features, FeatureCAM automatically:

- Selects the most appropriate tools and operations;
- Recommends machining strategies;
- Calculates speeds and feeds;
- Generates toolpaths and creates the NC code.

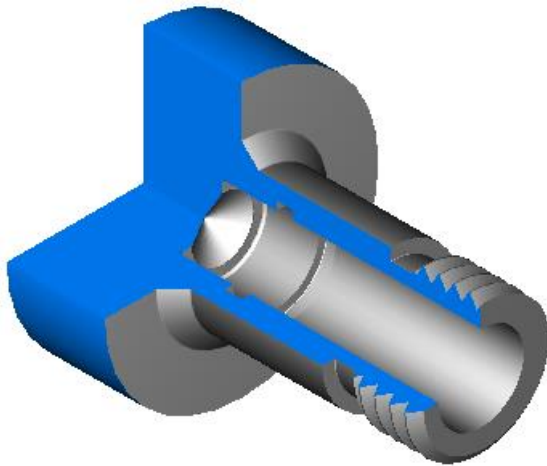
To view the simulated toolpath:

- 1 Click Home tab > Simulation panel > Sim mode menu > 3D to change the simulation type.

- 2 Click **Play**  on the Simulation toolbar to start the simulation.

If the **Automatic Ordering Options** dialog displays, click **OK** to close it.

This displays a solid 3D rendering of the cutting process. By default, the 3/4 view is shown when cutting or drilling the ID of the part.

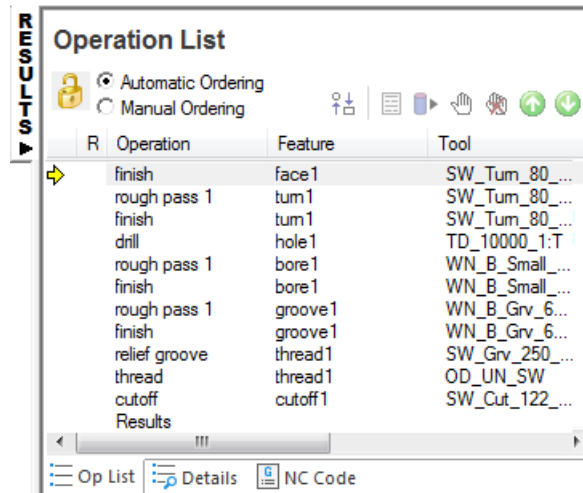


*If the 3/4 view is not displayed, select File > Options > Simulation > Round Stock tab > 3/4 view with lathe ID work, then click **OK** to close the dialog. Click the **Play**  button on the **Simulation** toolbar to see the changes.*

- 3 Click the **Play to Next Operation**  button. This displays the face operation.
- 4 Click **Play to Next Operation**  again to view each subsequent operation until you complete the simulation.
- 5 Click **Eject**  to end the simulation.

Order of manufacturing operations

The **Op List** tab in the **Results** window shows all of the operations needed to machine the features. A yellow warning ⚠ sign next to an operation indicates a potential problem with that operation. In this case, if you see any warnings ignore them.



You can control the automatic ordering of operations by using either rules or operation templates. The 2.5D Milling tutorial looks at using rules (see page 12).

This section changes the automatic ordering by modifying the **Turn Operation** template.

To modify the template

- 1 Select the **Automatic Ordering** option on the **Op List** tab. This ensures the automatic ordering rules are applied to the operations.
- 2 Change the automatic ordering to group together the operations which use the same tool.
 - a Click the **Ordering ordering options**  button.
 - b In the **Automatic Ordering Options** dialog, select **Use template**.
 - c Click **Edit template**.
- 3 In the **Feature Order** dialog:
 - a Select **Rough OD Turn**.
 - b Click  until **Rough OD Turn** is below **Finish ID Turn**.
 - c Click **OK** to close the **Feature Order** dialog.
- 4 Click **OK** to close the **Automatic Ordering Options** dialog.
- 5 Simulate the part.

- a Click Home tab > Simulation panel > Sim mode > 3D to change the simulation type.
- b Click **Play**  on the Simulation toolbar to start the simulation.
Notice that the OD roughing and finishing now happen after the hole is drilled.
- c Click **Eject**  to end the simulation.

Part documentation (Turning)

As well as simulating the manufacturing of the part, the simulation also generates complete tool and operations lists. The tools selected are based on your tool database. You can print this information to use as an operator's checklist by clicking **File > Print** and selecting **Operations List**.

- 1 Click the **Details** tab in the **Results** window to display the Manufacturing Operations sheet.

You can review this sheet using the scroll bars.

- 2 Select the **Tool List** option at the top of the **Details** tab to show the Manufacturing Tool Detail sheet. It contains all of the tools used to create the part based on the tool crib you selected.

Generating NC code (Turning)

FeatureCAM generates the NC code to manufacture parts on a CNC machine. You can generate NC code after you have simulated the part, and therefore calculated the toolpaths.

- 1 Select the **NC Code**  step from the **Steps** panel. This displays the **NC Code** dialog.
- 2 Click **Display the NC code in the results window**.

Changing the post processor

To change the post processor:

- 1 Click the **Customize Mfg.** step in the **Steps** panel.
- 2 Click **Configure postprocessor**.
- 3 Click **Browse** to view available post processors.
The default folder for posts is `..\Examples\Posts`.
- 4 Select your post processor and click **Open**.
The new post processor is displayed in the **CNC File** field.
- 5 Click **OK** to close the dialog.
- 6 Run a simulation of the part to regenerate the NC code.

Saving the NC code

To save an NC program:

- 1 Select the **NC Code**  step from the **Steps** panel. This displays the **NC Code** dialog.
- 2 Click **Save the NC code**.
- 3 In the **Save NC** dialog, accept the default filename and folder, and click **OK**.

Introduction to turn/mill

This tutorial introduces you to:

- Creating parts for lathes with milling capabilities.
- Mixing turning and milling features.
- Creating milling features on the outside diameter and face of the part.
- Simulating a turn/mill part.



FeatureCAM Premium is required for this functionality.

To use the turn/mill example, start FeatureCAM (see page 2), create a new file (see page 4) with a **Type** of **Turn/Mill Setup**, then follow these steps:

- 1 Preparatory steps (see page 35).
- 2 Define the geometry (see page 35).
- 3 Create the features (see page 37).
- 4 View the part (see page 38).
- 5 Create three radial holes on the face (see page 39).
- 6 Engrave the face (see page 41).
- 7 Create three slots (see page 43).
- 8 Simulate the toolpaths (see page 44).

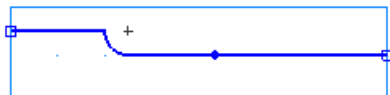
Preparatory steps

The preparatory steps define the stock and determine the coordinate system and view.

- 1 On the **Dimensions** page of the **Stock** wizard:
 - a Select a shape of **Round**.
 - b Enter an **OD** (outside diameter) of **3**.
 - c Enter a **Length** of **2**.
 - d Enter an **ID** (inside diameter) of **0**.
- 2 Click **Next** until you reach the **Part Program Zero** page.
- 3 Select **Align to stock face**.
- 4 Click **Next**.
- 5 Click  to position the datum of the part.
- 6 From the **Finish** menu, select the **Finish** button.
- 7 Click View tab > Navigate panel > Resize menu > Resize to fit.
- 8 Click File > Options > General > Dialogs, and under **Turning Diameter** select **Diameter (DZ)** to enter coordinates as **Diameter** and **Z** values.

Defining the geometry

This shows you how to design your part.



- 1 Draw three lines:
 - a Select the **Geometry**  step from the **Steps** panel. This displays the **Geometry Constructors** dialog.
 - b Select the **Create more than 1** option, and click the **Connected Lines**  button. This displays the **Feature/Geometry Edit** bar.
 - c To create two lines that define the outer profile, in the Feature/Geometry Edit bar:
For point 1 enter a **D/Z 1** of **D 2.5, Z 0**.

For point 2 enter a **D/Z 2** of **D 2.5, Z -1.5**.

Press **Enter** to create a line.

- d** Create a second line with the values:

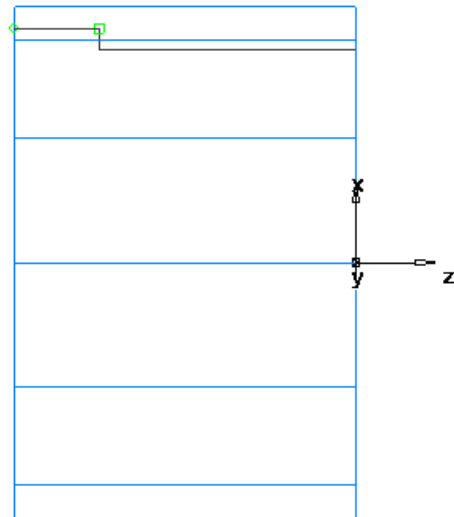
For point 2 enter a **D/Z 2** of **D 2.75, Z -1.5**.

Press **Enter** to create a second line.

- e** Create a third line with the values:

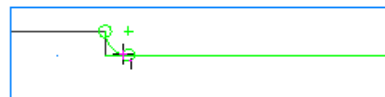
For point 2 enter a **D/Z 2** of **D 2.75, Z -2**.

Press **Enter** to create a third line.



- 2** Create a Fillet to trim your lines.

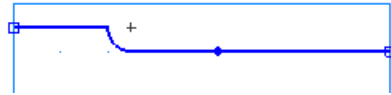
- a** Select the **Geometry**  step from the **Steps** panel.
- b** In the **Geometry Constructors** dialog, under **Fillet**, click **Construct a corner fillet**.
- c** In the Feature/Geometry Edit bar, enter a radius (**R**) of **0.125**.
- d** Position your mouse pointer in the corner between the first and second lines, and click to create the fillet. The fillet automatically trims your lines.



- 3** To turn the part you need to chain the curves.

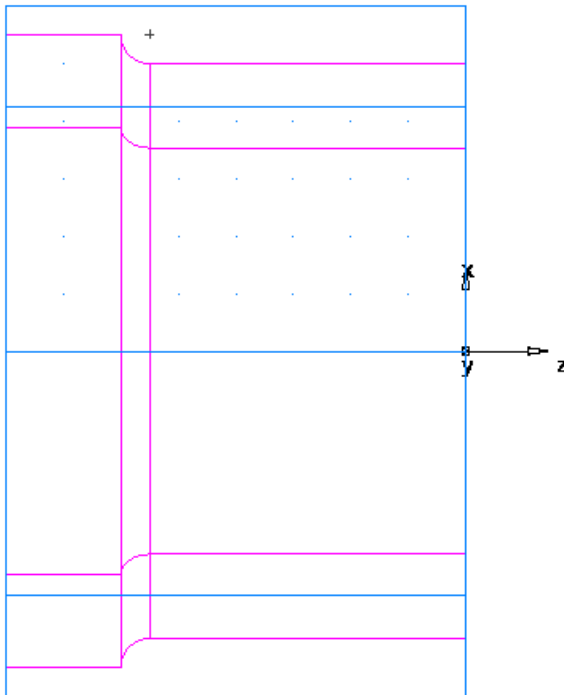
- a** Select the **Curves**  step from the **Steps** panel.
- b** In the **Curves Creation** dialog, select **Chain pieces of geometry into an open boundary using a mouse click at each end**.
- c** In the graphics window, click the first line and then the third line.

- d In the **Feature/Geometry Edit** bar, name the curve **Turn**, and press **Enter**.



Creating the features

This example shows you how to create the turning features.



- 1 Deselect View tab > Appearance panel > Line Display menu > Turning 2D View to return to a 3D view of the model.
- 2 Create a Turn feature.

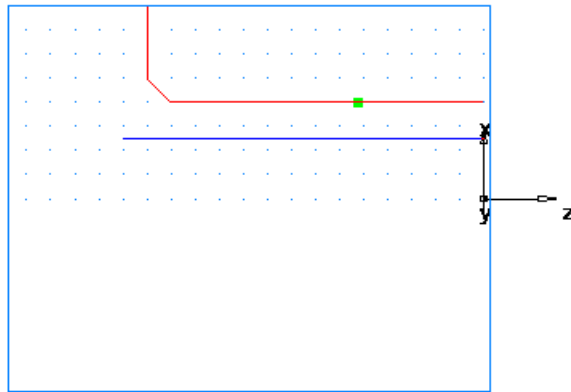
- a Click the **Features**  step in the **Steps** panel.
- b In Turn/Mill documents, the **New Feature** wizard asks you which type of feature you want to create. Select the **Turning** option, and click **Next**.
- c Select **Turn** in the **From Curve** section, and click **Next**.
- d In the **Curve** field select turn from the list.

Click the **Pick Curve**  button to select the curve graphically. The dialog minimizes to reveal the graphics window beneath.

Click the curve you named **Turn** earlier.

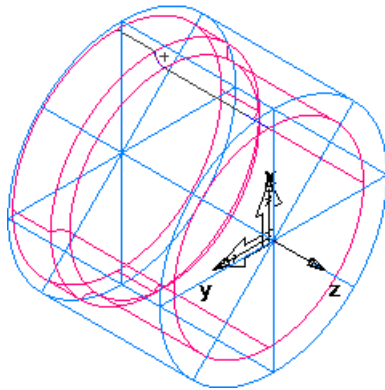
In the **Select** dialog, select **turn**, and click **OK**.

- e Click **Finish**.



Viewing the part

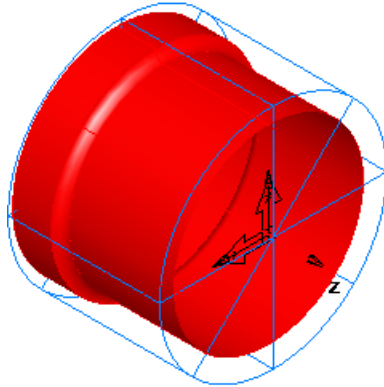
- 1 Click View tab > Views panel > Isometric Views menu > Isometric.



If this displays a 2D representation of the part, deselect View tab > Appearance panel > Line Display menu > Turning 2D View to return to a 3D view of the model.

- 2 Shade the part:
 - a Open the **Part View** panel, and select **turn1** under the **Setup1** node.

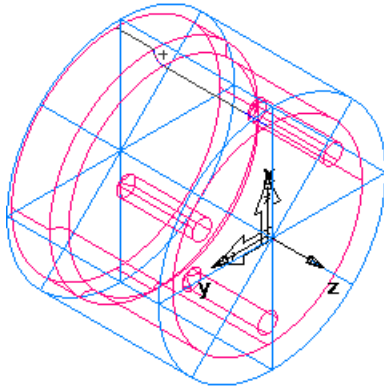
- b** Select View tab > Appearance panel > Shading menu > Shade Selected.



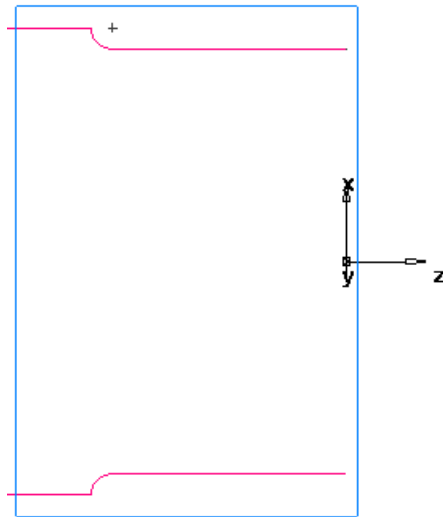
- 3** Select View tab > Appearance panel > Shading menu > Unshade All to return to the wireframe view of the part.
- 4** To change the view to a top view, click View tab > Views panel > Principal Views menu > Top.

Creating three radial holes on the face

This shows you how to add three Holes to the part.



- 1 Select View tab > Appearance panel > Line Display menu > Turning 2D View to switch to a simplified 2D representation of the part.



- 2 Create a Hole.

- a Click the **Features**  step in the **Steps** panel.
- b In the **New Feature** wizard, select the **Turn/Mill** option, and click **Next**.
- c In the **From Dimensions** field, select **Hole** and click **Next**.
- d In the **Dimensions** dialog:
Enter a **Chamfer** of **0.0**.
Enter a **Depth** of **1.0**.
Enter a **Diameter** of **0.25**.
- e Click **Finish and Create More**.

- 3 Create a Pattern from feature:

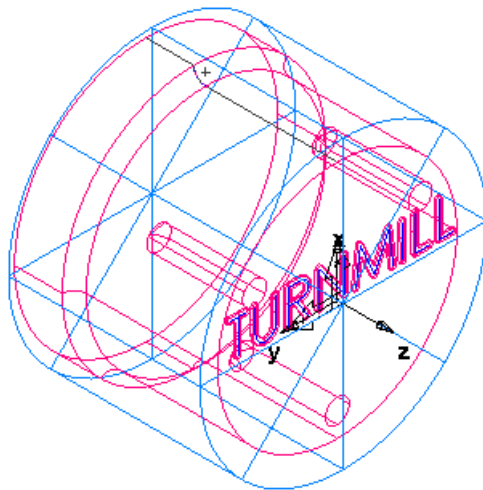
- a In the **New Feature** wizard, select the **Turn/Mill** option, and click **Next**.
- b In the **From Feature** field, select **Pattern**, and click **Next**.
- c Select the hole you just created and click **Next**.
- d Select **Radial** in the setup **XY plane**, and click **Next**.
- e On the **Pattern - Dimensions** page:
Enter a **Number** of **3.0**.
Enter a **Diameter** of **2.0**.
Enter a **Spacing Angle** of **120**.
Enter an **Angle** of **60**.

- f** Click **Finish**.
- g** Click **Cancel**.
- 4** View the 3D wireframe representation of the part:
 - a** Deselect View tab > Appearance panel > Line Display menu > Turning 2D View to return to a 3D view of the model.
 - b** Click View tab > Views panel > Isometric Views menu > Isometric.

Engraving the face

This shows you how to engrave the part by:

- Creating the engraving text.
- Creating a Groove feature.



- 1** Create a curve.

- a** Select the **Curves**  step from the **Steps** panel.
- b** In the **Curves Creation** dialog, select **Chain pieces of geometry into an open boundary using a mouse click at each end**.
- c** In the **Curve** wizard:
 - Select **Other methods** as the construction method.
 - Select **Text** as the constructor.
 - Click **Next**.
- d** On the **Engraving Text** page, configure the text properties.
 - Enter a **Text** of **TURNMILL**.
 - Select a **Path type** of **Linear**.
 - Enter a location of **X 0.0, Y -0.045, Z 0.0**.

Enter an **Angle** of **-90**.

From the **Justification** list, select **Center**.

Enter a **Scaling** of X **0.4**, Y **0.4**.

Click the **Font** button to display the **Font** dialog.

From the **Font** list, select **Machine Tool Gothic**.

Enter a **Size** of **72**.

Click **OK** to close the dialog.

e Click **Finish** to close the wizard.

2 Create a Groove feature.

a Select the **TURNMILL** text (**curve1**) in the graphics window.

b Click the **Features**  step in the **Steps** panel.

c In the **New Feature** wizard, select the **Turn/Mill** option, and click **Next**.

d In the **From Curve** field, select **Groove**, and click **Next**.

e On the **Curve** page, click **Next** (as you have selected the text in step 2a).

f On the **Location** page, click **Next**.

g On the **Dimensions** page:

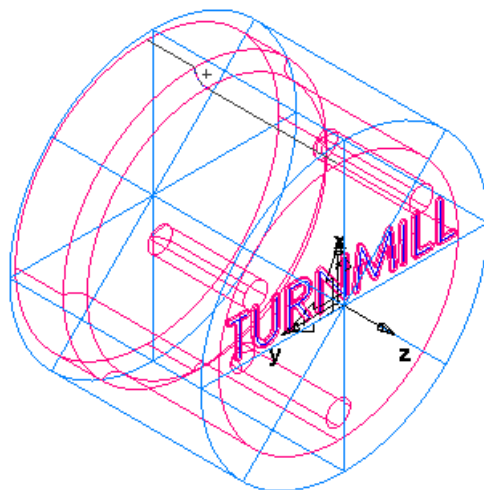
Enter a **Width** of **0.0625**.

Enter a **Depth** of **0.02**.

Select **Face**.

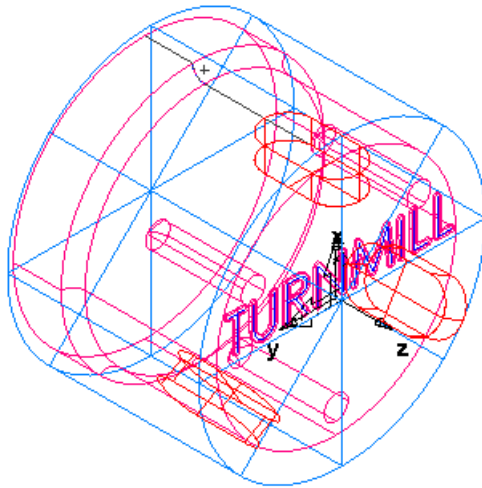
Select **Simple (Engrave)**.

h Click **Finish**.



Creating three slots

This shows you how to add three milled slots to the part.



1 Create a Slot feature:

- a Click the **Features**  step in the **Steps** panel.
- b In the **New Feature** wizard, select the **Turn/Mill** option, and click **Next**.
- c In the **From Dimensions** section, select **Slot**.
Select **Make a pattern from this feature**, and click **Next**.
- d On the **Dimensions** page:
Enter a **Length** of **1.0**.
Enter a **Width** of **0.5**.
Enter a **Depth** of **0.25**.
Click **Next**.
- e On the **Patterns** page select **Radial around index axis**, and click **Next**.
- f On the **Location** page:
Enter a **B Angle** of **90**.
Enter a **Radius** of **1.25**.
Enter a **Z** to **0.25**.
Click **Next**.
- g On the **Dimension** page:
Enter a **Number** of **3**.
Enter a **Spacing Angle** of **120**.
- h Click **Finish**.

Simulating the toolpaths

To view the simulated toolpath:

- 1 Click the **Customize Mfg.** step in the **Steps** panel.
- 2 Click **Configure postprocessor**.
- 3 Select a CNC file for a machine that supports live tooling. For example:
`..\Examples\Posts\TurnMill\Skeleton\skeleton-1-turret.cnc`
- 4 Click Home tab > Simulation panel > Sim mode menu > 3D to change the simulation type.
- 5 Click **Play**  on the Simulation toolbar to start the simulation.



The toolpaths are accurately simulated including the part rotations.

- 6 Click **Eject**  to end the simulation.

Introduction to 3D milling

This tutorial introduces you to:

- Modeling 3D surfaces.
- Manufacturing surfaces using surface milling features.
- Manufacturing operations.
- Tool selection.
- 3D manufacturing attributes.



*FeatureCAM Premium is required for this functionality. You must have the **basic** tool crib installed.*

This tutorial shows you how to create a simple part, generate toolpaths and output the toolpaths used to machine the part.

To use the 3D milling example, start FeatureCAM (see page 2), create a new file (see page 4), then follow these steps:

- 1 Define the Stock (see page 46).
- 2 Define the geometry (see page 46).
- 3 Create the bottle surface (see page 50).
- 4 View the part (see page 51).
- 5 Create a surface milling feature (see page 53).
- 6 Simulate the toolpaths (see page 54).

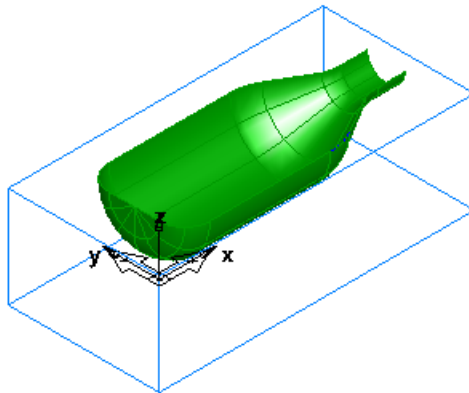
Defining the Stock

The stock is the initial material from which you cut your part.

- 1 On the **Dimensions** page of the **Stock** wizard:
 - a Enter a **Thickness** of **2**.
 - b Enter a **Width** of **3**.
 - c Enter a **Length** of **6.25**.
 - d Click **Finish**.
- 2 Click **OK** to accept the default values of the **Stock Properties** dialog.

Defining the geometry

This shows you how to design your part.



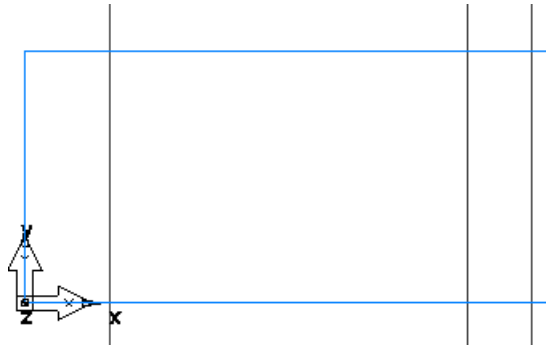
- 1 Create three vertical lines:
 - a Click Construct tab > Geometry panel > Line menu > 2 Points.

The Feature/Geometry Edit bar is displayed.

D/Z 1	0.0000	0.0000	0.0000	D/Z 2	0.0000	0.0000	0.0000	A	45	L	1.0000	Create
												Options

- b In the Feature/Geometry Edit bar, enter an XYZ of X **1**, Z **0**, and press **Enter**.
 - c Create a second line by entering an XYZ of X **5.25**, Z **0**, and press **Enter**.

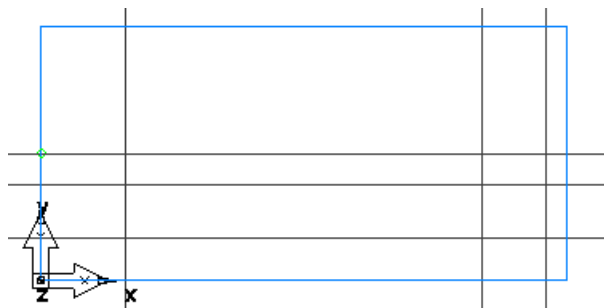
- d** Create a third line by entering an XYZ of X **6**, Z **0**, and press **Enter**.



2 Create three horizontal lines:

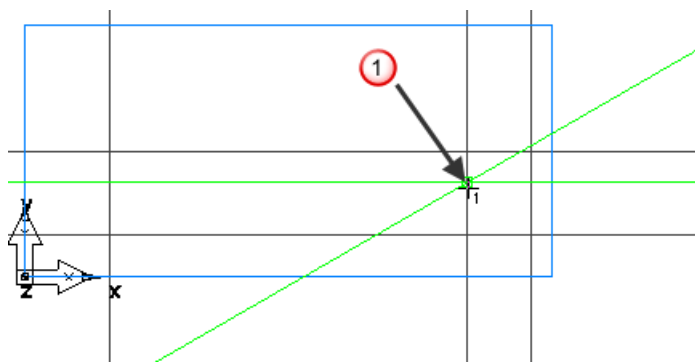
Click Construct tab > Geometry panel > Line menu > Horizontal.

- a** Enter an XYZ of Y **0.5**, Z **0**, and press **Enter**.
- b** Create a second line by entering an XYZ of Y **1.125**, Z **0**, and press **Enter**.
- c** Create a third line by entering an XYZ of Y **1.5**, Z **0**, and press **Enter**.



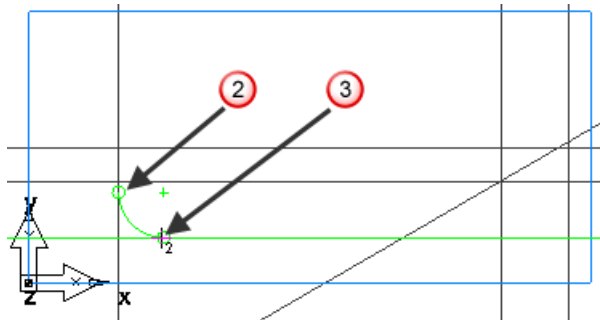
1 Create a through line:

- a** Click Construct tab > Geometry panel > Line menu > Point, Angle.
- b** In the Feature/Geometry Edit bar, enter an angle **A** of **30**.
- c** In the graphics window, click at the intersection between the second horizontal and second vertical lines, at point **1**, to create a through line.



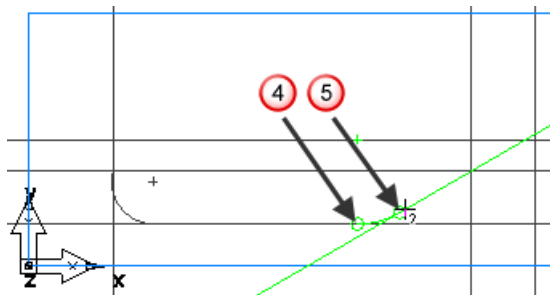
2 Create arcs.

- a On the **Geometry** toolbar, select **2 Pts, Radius**  from the **Arc**  menu.
- b Click Construct tab > Geometry panel > Arc menu > 2 Points, Radius.
- c In the Feature/Geometry Edit bar, enter a radius **R** of **0.5**, and click the vertical line around point **②** and the horizontal line around point **③**.

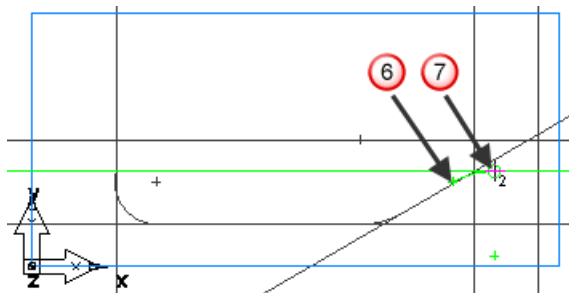


d Create the second arc:

In the Feature/Geometry Edit bar, enter a radius **R** of **1.0**, and click the horizontal line around point **④** and the through line around point **⑤**.



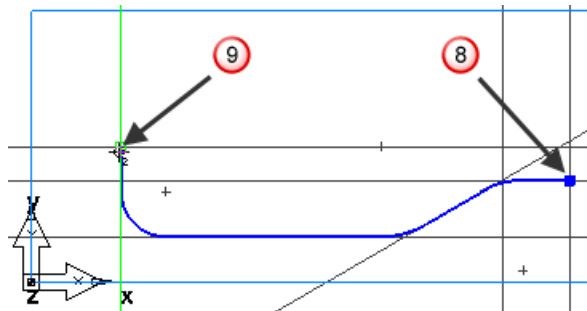
e Create the third arc by clicking the through line around point **⑥** and the horizontal line around point **⑦**.



3 To mill the part you need to chain the curves.

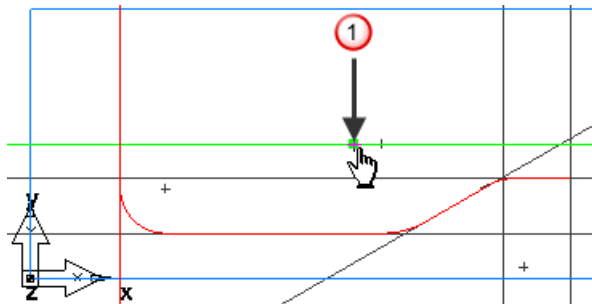
- a Select the **Curves**  step from the **Steps** panel.

- b** In the **Curves Creation** dialog, select **Chain pieces of geometry** into an open boundary using a mouse click at each end.
- c** Click at the intersection of the vertical and horizontal line at point **8** and at the intersection of the vertical and horizontal line at point **9**.

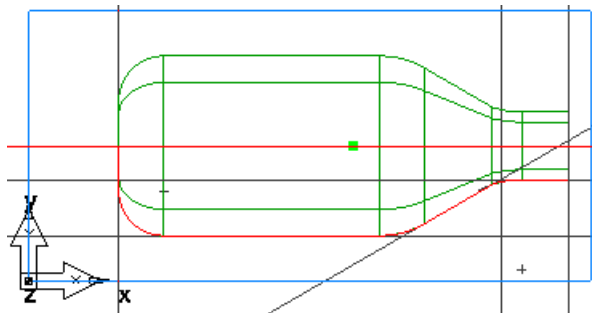


Creating the bottle surface

- 1 Select the **Surfaces**  step from the **Steps** panel.
- 2 In the **Surface** wizard, select **Surface of Revolution**, and click **Next**.
- 3 On the **Surface of Revolution** page:
 - a Enter a **Start Angle** of **0**.
 - b Enter an **End Angle** of **180**.
 - c FeatureCAM automatically selects your chained curve in the **Curve** field.
 - d In the **Axis** field, click the **Pick line**  button, and select the horizontal line around point **1**.

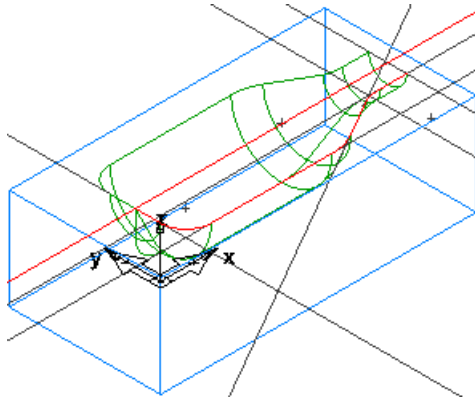


Click **Finish**.



Viewing the part

- 1 Click View tab > Views panel > Isometric Views menu > Isometric.



- 2 Control how the part is displayed using the Display Options.

- a Click File > Options > Display > Wireframe tab and select **Show surface boundaries only**, and click **OK**.

This displays the surfaces as only their outer boundaries and trimmed loops. No additional lines are drawn in the interior of the surface. This makes the display of larger models much faster.

- b Click File > Options > Display > Wireframe tab and deselect **Show surface boundaries only**, and click **OK**.

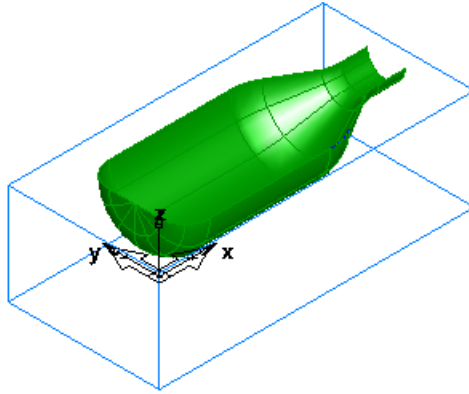
This displays the surfaces with lines in the interior of the surface. This aids visualization, but for large models, it makes the display of the part slower.

- c Click File > Options > Display > Wireframe tab and enter a **Surface fineness Wireframe** of **20**, and click **OK**.

This displays the surfaces with more lines. Decreasing the value of **Surface Fineness** improves the display quality but slows down the graphics.

- 3 Click View tab > Visibility panel > Hide menu > Hide All Geometry.
- 4 Click View tab > Visibility panel > Show menu > Show All Surfaces.

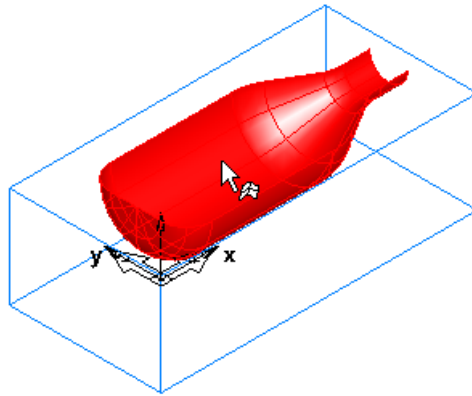
- 5 Click View tab > Appearance panel > Shading menu > Shade Surfaces.



Creating a surface milling feature

This shows you how to create the surface features and select the toolpath strategies.

- 1 Press the **Esc** key to cancel any geometry creation modes.
- 2 Select the surface (srf1). On selection it turns red.

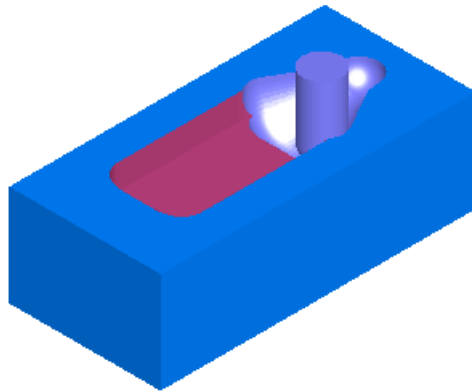


- 3 Select the **Features**  step from the **Steps** panel.
- 4 In the **New Feature** wizard, in the **From Surface** frame, select the **Surface Milling** option, and click **Next**.
- 5 On the **Part Surface** page click **Next**.
- 6 On the **New Strategy** page, select the **Choose Rough, Semi Finish, and Finish...** option, and click **Next**.
- 7 On the **Rough** page:
 - a Select the **Z Level Rough** option.
 - b Select **Classify slices as 3D Pocket**.
 - c Click **Next**.
- 8 On the **Semi-Finish** page, select **None**, and click **Next**.
- 9 On the **Finish** page, select **Isoline**.
- 10 Click the **Finish** button.

Simulating the toolpaths

To view the simulated toolpath:

- 1 Click Home tab > Simulation panel > Sim mode menu > 3D to change the simulation type.
- 2 Click **Play**  on the Simulation toolbar to start the simulation.



The toolpaths are accurately simulated including the part rotations.

- 3 Click **Eject**  to end the simulation.
- 4

Introduction to wire EDM

This tutorial introduces you to the basics of creating wire EDM toolpaths. It looks at:

- Setting up your material and wire thickness.
- Creating wire EDM features.
- Specifying a wire EDM cutting strategy.
- Simulating wire EDM toolpaths.



FeatureCAM Premium is required for this functionality.

To use the wire EDM example, start FeatureCAM (see page 2), create a new file (see page 4) with a **Type** of **Wire EDM Setup**, then follow these steps:

- 1 Define the stock (see page 55).
- 2 Create the profile (see page 56).
- 3 Create a wire EDM feature (see page 56).
- 4 Simulate the wire EDM toolpath (see page 57).
- 5 Generate NC code (Wire EDM) (see page 59).
- 6 Add a taper angle (see page 60).

Defining the stock

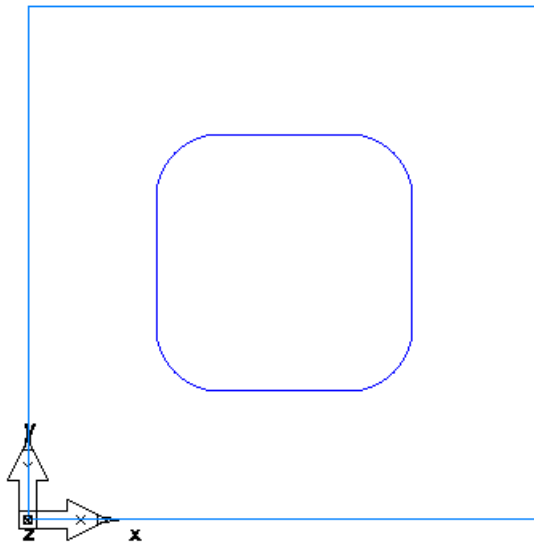
The preparatory steps define the stock and determine the coordinate system and view.

- 1 On the **Dimensions** page of the **Stock** wizard:
 - a Enter a **Width** of **0.5** (**12** mm).
 - b Enter a **Length** of **4** (**100** mm).
 - c Enter a **Thickness** of **4** (**100** mm).

- d From the **Finish** menu button select the **Finish** button.

Creating the profile

This step defines the profile.

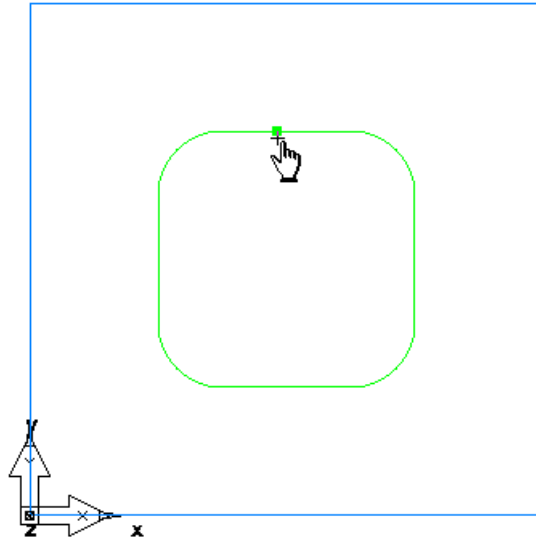


- 1 Select the **Curves**  step from the **Steps** panel.
- 2 In the **Curves Creation** dialog, select the **Curve Wizard**  button.
- 3 In the **Curve Wizard**:
 - a Select a construction method of **Other methods**.
 - b Select a constructor of **Rectangle**.
- 4 Click **Next**.
- 5 On the **Rectangle** page:
 - a Select **Use corner, width, and height**.
 - b Enter corner point of **1, 1, 0**.
 - c Enter a corner radius of **0.5**.
 - d Enter a **Width** of **2.0**.
 - e Enter a **Height** of **2.0**.
 - f Click **Finish**.

Creating a wire EDM feature

This shows you how to create a wire EDM feature.

- 1 Select the **Features**  step from the **Steps** panel.
- 2 In the **New Feature** wizard, select the **Die** option in the **2 Axis** frame, and click **Next**.
- 3 On the **Curves** page, click the **Pick curve or geometry**  button, select the curve you created, and click **Next**.



- 4 On the **Location** page, click **Next**.
- 5 On the **Dimensions** page, enter a **Thickness** of **0.5** and click **Next**.
- 6 On the **Start** page, click **Next**.
- 7 On the **Strategies** page:
 - a In the **Operations** field select **Retract**.
 - b Select the **Cutoff** option.
 - c Select the **Contour** option.
 - d Click **Finish**.

Simulating the wire EDM toolpath

Now you have created the features, FeatureCAM automatically:

- Selects the most appropriate tools and operations;
- Recommends machining strategies;
- Calculates speeds and feeds;
- Generates toolpaths and creates the NC code.

To view the simulated toolpath:

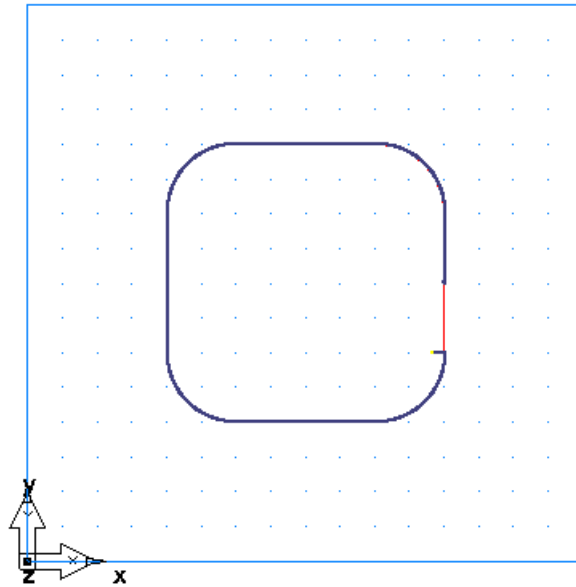
- 1 Click Home tab > Simulation panel > Sim mode menu > 2D to change the simulation type.

2 Center the Simulation Speed slider  to specify the simulation rate.

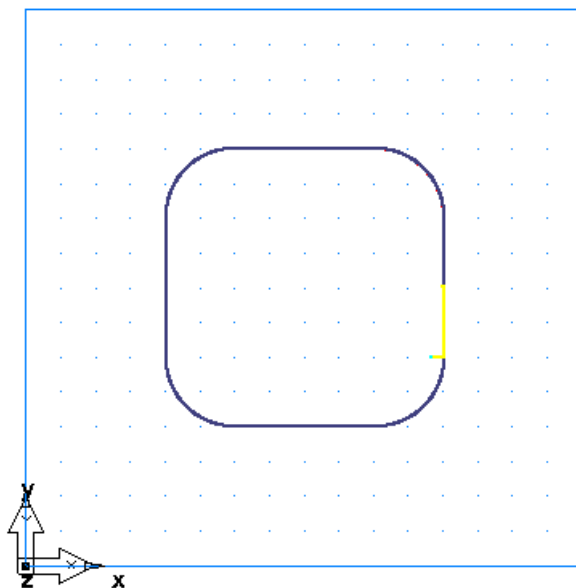
3 Click **Play to Next Operation**  to see the retract operation.



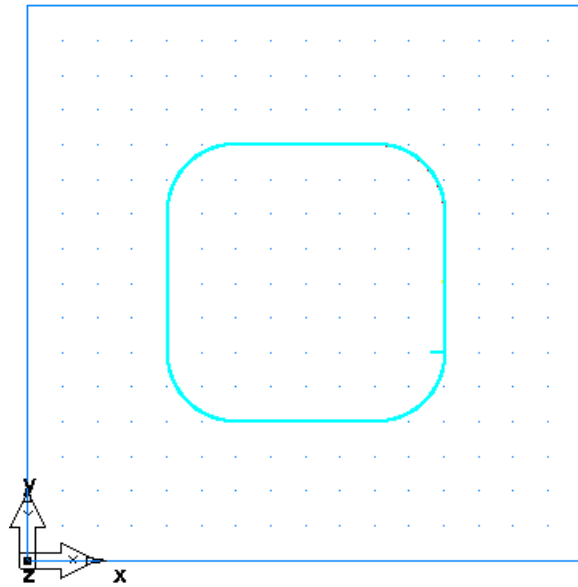
*To slow down the simulation, drag the **Simulation Speed** slider to the left.*



4 Click the **Play to Next Operation**  button again to see the cutoff operation.



- 5 Click the **Play to Next Operation**  button again to see the final contour operation.



- 6 Click **Eject**  to end the simulation.

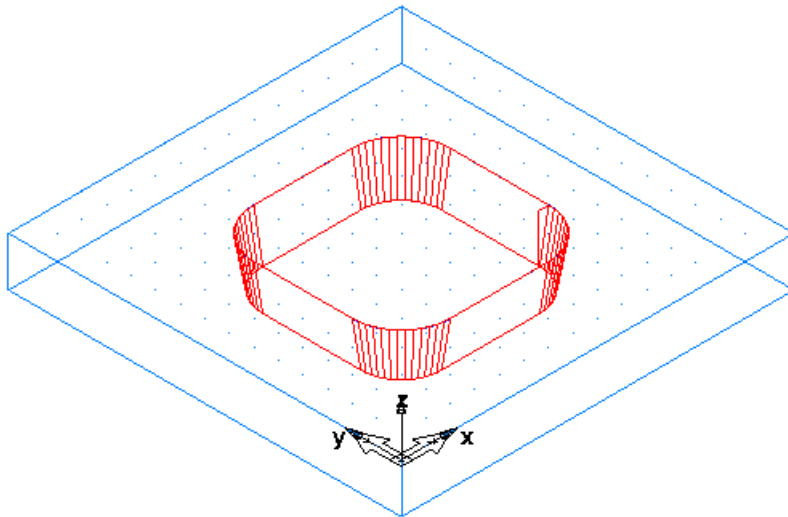
Generating NC code

FeatureCAM generates the NC code to manufacture parts on a CNC machine. You can generate NC code after you have simulated the part, and therefore calculated the toolpaths.

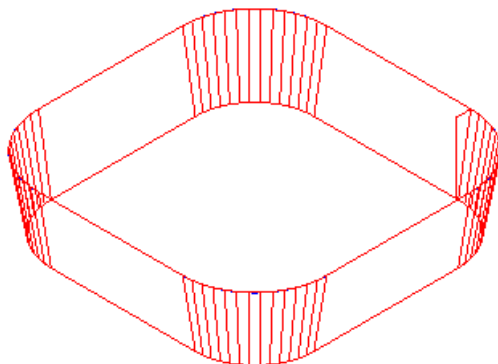
- 1 Select the **NC Code**  step from the **Steps** panel. This displays the **NC Code** dialog.
- 2 Click **Display the NC code in the results window**.

Adding a taper angle

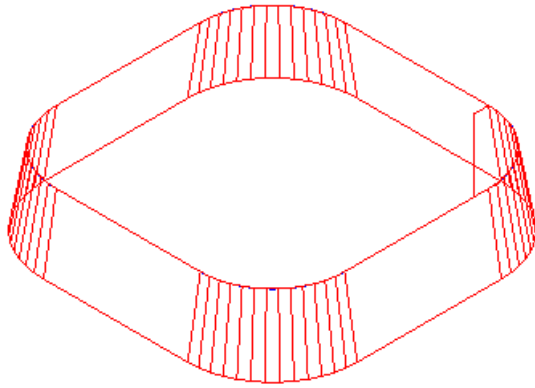
This example shows you how to add a draft angle to a wire EDM part.



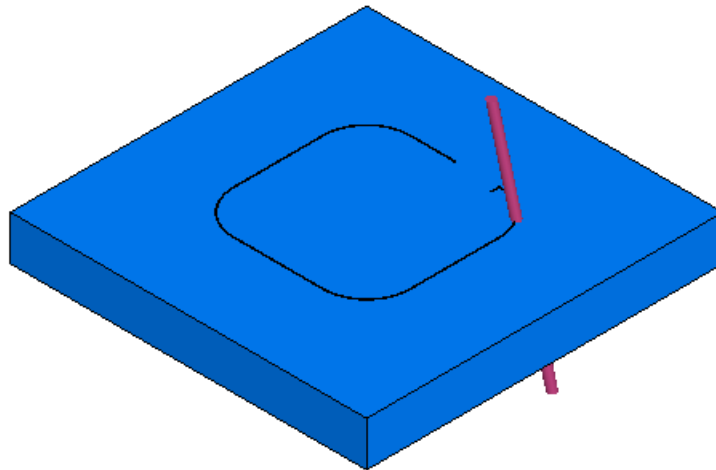
- 1 Open the **Part View** panel, right-click the **die1** feature under **Setup1** and select **Properties**.
- 2 In the **Properties** dialog for **die1**:
 - a Select **Constant**.
 - b Select a taper type of **Left**.
 - c Enter a **deg.** of **10** as the taper angle.
 - d Click **Apply**.
- 3 Click View tab > Visibility panel > Hide menu > Hide Stock.
- 4 Click View tab > Views panel > Isometric Views menu > Isometric.



- 5 Return back to the **Properties** dialog, set the taper type to **Right**, and click **Apply**.

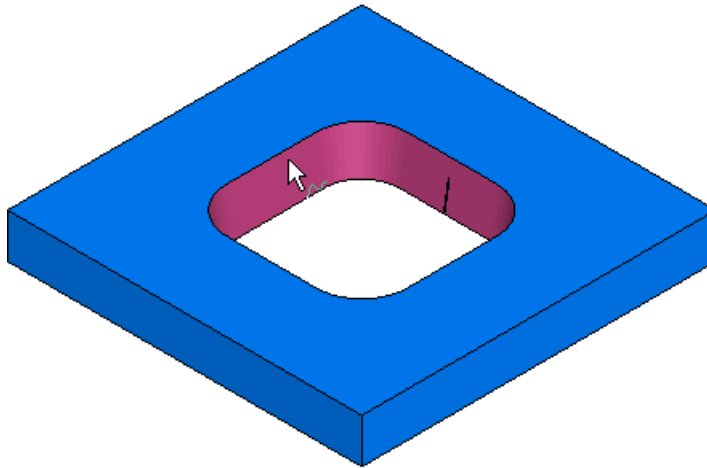


- 6 Change the taper type back to **Left**, and click **OK** to close the **Properties** dialog.
- 7 Click Home tab > Simulation panel > Sim mode menu > 3D to change the simulation type.
- 8 Click **Play**  on the Simulation toolbar to start the simulation.



- 9 Click Home tab > Select & Edit panel > Select menu > Single or Box Select.

10 Click inside the curve to hide that part of the stock.



11 Click **Eject**  to end the simulation.

12 Click View tab > Visibility panel > Show menu > Show Stock.

Introduction to Feature Recognition

There are two types of Feature Recognition in FeatureCAM, which you can learn about in the following examples:

- Automatic Feature Recognition (see page 64) — Automatically recognize all features in a solid model.
- Interactive Feature Recognition (see page 70) — Recognize individual features from a solid model.

Automatic Feature Recognition example

This example shows you how to use Automatic Feature Recognition to recognize features in a solid model.

To use the Automatic Feature Recognition example, start FeatureCAM (see page 2), create a new file (see page 4), then follow these steps:

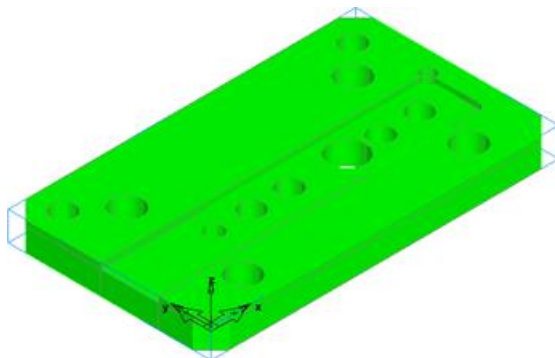
- 1 Import the **Hole Recogn ug_plate.x_t** solid model (see page 65).
- 2 Use Automatic Feature Recognition to create the features (see page 67).
- 3 Simulate the toolpaths (see page 69).

Importing the solid model

This step shows you how to import a solid model into FeatureCAM.

To import the solid model:

- 1 Click **File > Import** to display the **Import** dialog.
- 2 Navigate to the `\Examples\FeatureRECOGNITION` folder.
- 3 Select the **Hole Recog ug_plate.x_t** file and click **Open**.
The **Import Results** dialog is displayed.
- 4 Select **Use the wizard to establish the initial setup location and stock size** and click **Next**.
The **Pick Initial Setup Z Direction** page is displayed.
- 5 Click **Next**.
The **Pick Initial Setup X Orientation** page is displayed.
- 6 Click **Next**.
The **Stock Type** page is displayed.
- 7 Select **Block** and click **Next**.
The **Stock Dimensions** page is displayed.
- 8 Select **Compute stock size from the size of the part** and click **Next**.
The **Pick Initial Setup XYZ Location** page is displayed.
- 9 Click  **LL**.
This locates the Setup (the part's coordinate system origin on the machine) in the lower-left corner of the stock.
- 10 Click **Finish** to close the Import wizard.
The part is imported into the document.
- 11 Click **View tab > Views panel > Isometric Views menu > Isometric**.





*You can learn more about the options available in the Import wizard by clicking the **Help** button on each page.*

Using Automatic Feature Recognition

This step shows you how to use Automatic Feature Recognition to create features.

To use Automatic Feature Recognition:

- 1 Select the **AFR** step in the **Steps** panel.

The **Automatic Feature Recognition** dialog is displayed.

- 2 Select your imported solid in the list.

- 3 Click **Options**.

The **AFR Options** dialog is displayed.

- 4 In the **AFR Options** dialog:

- a Select **Create face feature**
- b Select **Create hole pattern**
- c Deselect **Create 3D feature**

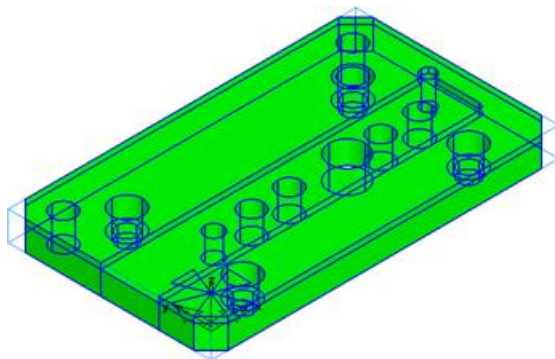
- 5 Click **OK** to close the **AFR Options** dialog.

- 6 Click **Next**.

The Setups page is displayed. You can use this page to select on which Setups the recognized features are created. In this example there is only one Setup.

- 7 Click **Next**.

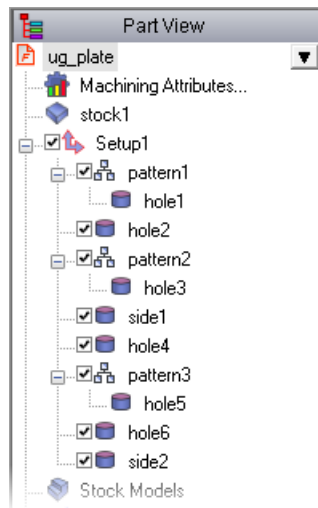
The features page is displayed. A list is displayed of all the recognized features, and a wireframe preview is displayed in the graphics window.



You can deselect features in the list that you do not want to create. In this tutorial, you do not need to create a Face feature.

- 8 Deselect **face 01** in the list.
- 9 Click **Finish** to create the selected features.

The created features are displayed in the **Part View**.



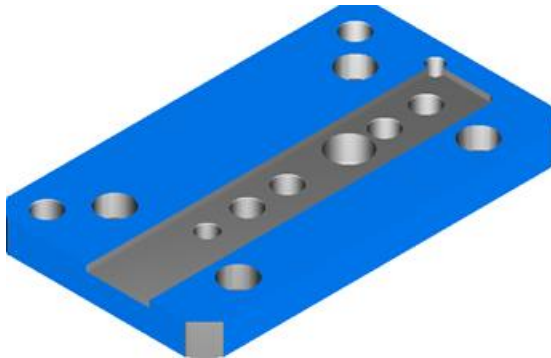
You can move the cursor over an item's name in the **Part View** to highlight it in the graphics window.

Simulating the toolpaths (AFR)

You can now simulate the toolpaths to see the result of the feature recognition.

To simulate the toolpaths:

- 1 Click Home tab > Simulation panel > Sim mode menu > 3D to change the simulation type.
- 2 Click **Play**  on the Simulation toolbar to start the simulation.
The 3D cutting simulation is displayed in the graphics window.



If there are any gouges, the simulation is paused and a warning is displayed.

- 3 When the simulation is complete, check the part to ensure there are no gouges and all the features have been machined correctly.
- 4 Click **Eject**  to end the simulation.

Interactive Feature Recognition example

This example shows you how to use Interactive Feature Recognition to recognize features in a solid model.

To use the Interactive Feature Recognition example, start FeatureCAM (see page 2), create a new file (see page 4), then follow these steps:

- 1 Import the **Integrex.sat** solid model (see page 71).
- 2 Use Interactive Feature Recognition to create the features (see page 73).
- 3 Change the tool selection (see page 76).
- 4 Simulate the toolpaths (see page 78).

Importing the solid model

This step shows you how to import a solid model into FeatureCAM.

To import the solid model:

1 If the **Dimensions** dialog is displayed, click **Cancel** to close it.

2 Click **File > Import** to display the **Import** dialog.

3 Navigate to the `\FeatureCAM\Examples\FeatureRECOGNITION` folder.

4 Select the **Integrex.sat** file and click **Open**.

The **Import Results** dialog is displayed.

5 Select **Use the wizard to establish the initial setup location and stock size**.

6 Click **Next**.

The **Pick Initial Setup Z Direction** page is displayed.

7 Click **Next**.

The **Pick Initial Setup X Orientation** page is displayed.

8 Click **Next**.

The **Stock Type** page is displayed.

9 Select **Block** and click **Next**.

The **Stock Dimensions** page is displayed.

10 Select **Compute stock size from the size of the part** and click **Next**.

The **Pick Initial Setup XYZ Location** page is displayed.

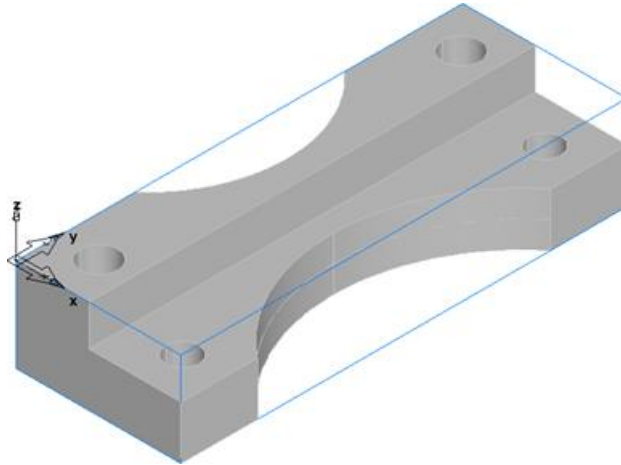
11 Click  **LL**.

This locates the Setup (the part's coordinate system origin on the machine) in the lower-left corner of the stock.

12 Click **Finish** to close the Import wizard.

The part is imported into the document.

- 13 Click View tab > Views panel > Isometric Views menu > Isometric 2 to select an isometric view.



*You can learn more about the options available in the Import wizard by clicking the **Help** button on each page.*

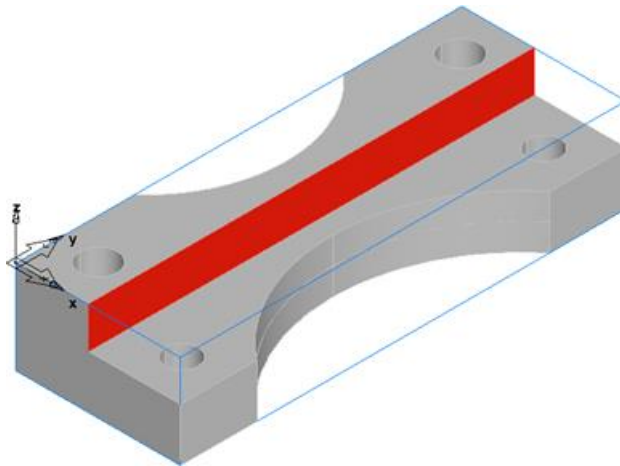
Using Interactive Feature Recognition

This step shows you how to use Interactive Feature Recognition to create features. In this example you will create Side features and then Hole features.

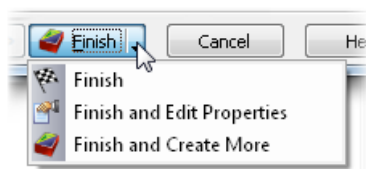
Creating the Side features

To create the Side features:

- 1 Click the **Features**  step in the **Steps** panel.
The **New Feature** dialog is displayed.
- 2 Under **From Curve**, select **Side**.
- 3 Select **Extract with FeatureRECOGNITION**.
- 4 Click **Next**.
The **Feature Extraction** page is displayed.
- 5 Select **Select side surfaces** and click **Next**.
The **Surface** page is displayed.
- 6 In the graphics window, select the surface on which to create the flat Side feature.



- 7 On the **Surfaces** page, click **Add from selected items**  to add the surface to the list.
- 8 Click the arrow on the **Finish** button, and then click **Finish and Create More**.



The feature is created and the **New Feature** dialog is displayed.

- 9 Ensure **Side** and **Extract with FeatureRECOGNITION** are selected, and click **Next**.

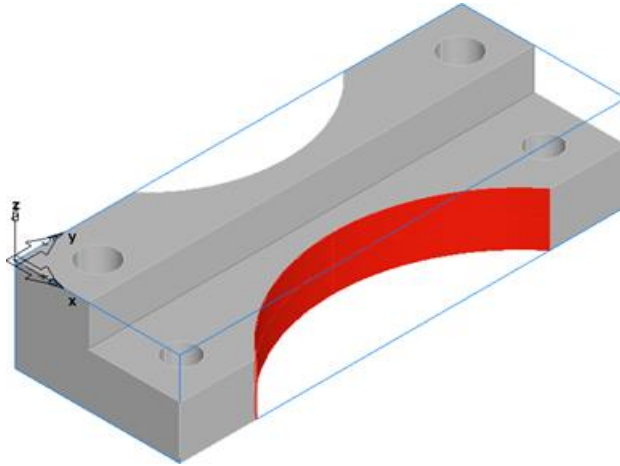
The **Feature Extraction** page is displayed.

- 10 Select **Select side surfaces** and click **Next**.

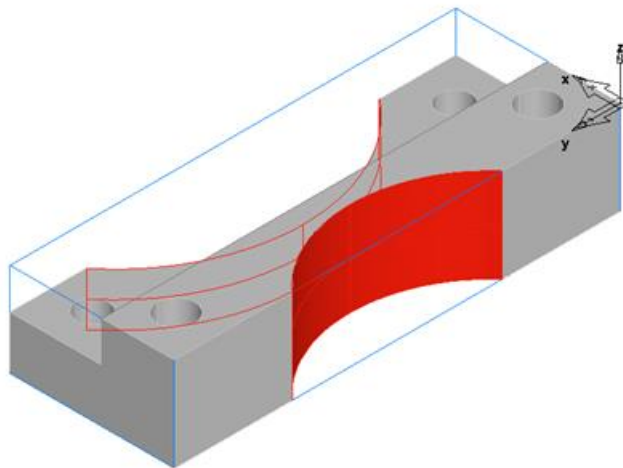
The **Surface** page is displayed.

- 11 In the graphics window, select the surfaces on which to create the curved Side features, on both the front and back of the part.

Front:



Back:



*Hold the **Shift** key and click to select multiple surfaces.*



*Press the **Ctrl+3** or **Ctrl+7** to select the back and front isometric views.*

- 12 On the **Surfaces** page, click **Add from selected items**  to add the surfaces to the list.

- 13 Click the arrow on the **Finish** button, and then click **Finish** to create the features and close the dialog.

Creating the Hole features

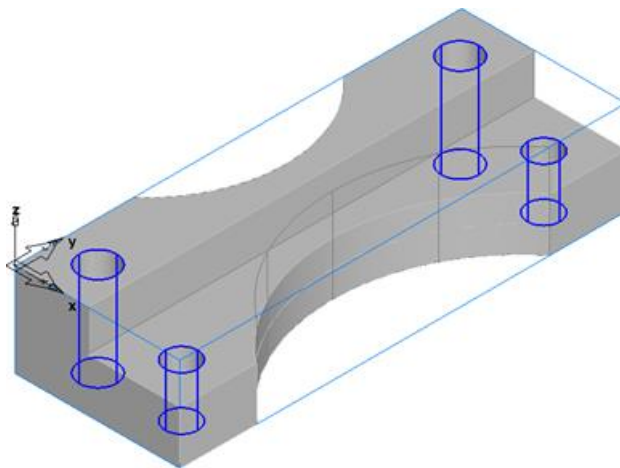
To create the Hole features:

- 1 Click the **Features**  step in the **Steps** panel.
The **New Feature** dialog is displayed.
- 2 Under **From Dimensions**, select **Hole**.
- 3 Ensure **Extract with FeatureRECOGNITION** is selected.
- 4 Click **Next**.

The **Hole Recognition Method** page is displayed.

- 5 Select **Recognize and construct multiple holes** and click **Next**.

A preview of the recognized Holes is displayed in the graphics window.



You can now select the Holes you want to create. Selected Holes are displayed in red.

- 6 Click **Select All** to select all the recognized Holes.
- 7 Click **Finish** to create the Hole features and close the dialog.

Tool selection (IFR)

When using Feature Recognition, it is possible to create features that you do not have the tools to machine.

In this example, there is no tool that meets the requirements for drilling the large Holes. If you try to run a simulation, the **Code Generation Failed** message is displayed.

When this happens, you can:

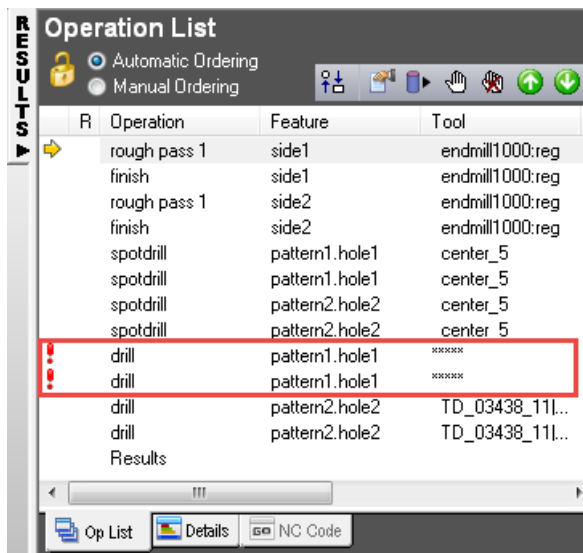
- add a new tool to your tool library that is the correct size to machine the feature; or
- machine the feature with an existing tool.

In this example, you will use an existing tool.

To select a tool to machine the feature:

- 1 In the **Results** window, select the **Op List** tab.

The **Operation List** is displayed. The operations with no tool selected have a red exclamation mark, and no tool name.

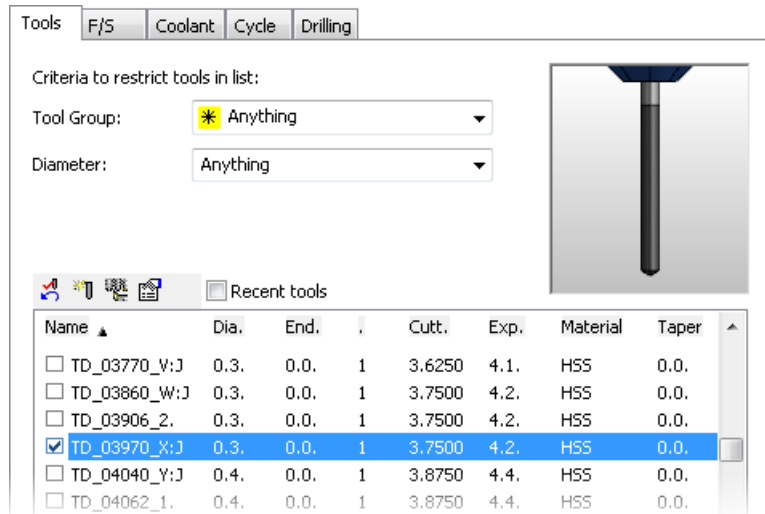


- 2 Double-click an operation with no tool to display the Feature Properties dialog.

- 3 Select the **Tools** tab.

A list of available tools is displayed.

- 4 Select the check mark to the left of a tool, such as **TD_03970_X:J**, to use this tool.



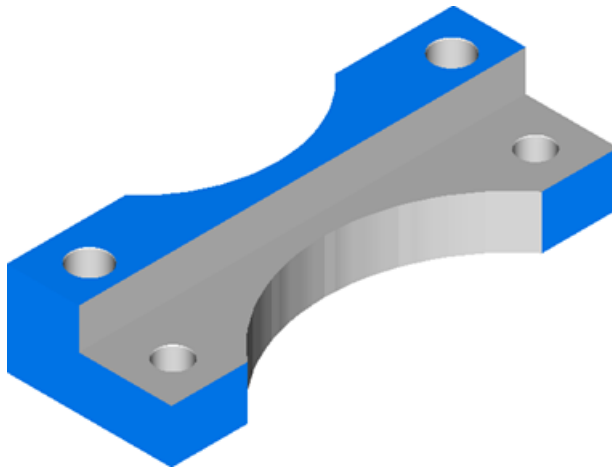
- 5 Click **OK** to accept your changes and close the dialog.

Because similar Hole features are created as patterns instead of individual features, you only need to edit one feature and your changes are applied to all the features in the pattern.

Simulating the toolpaths (IFR)

You can run a 3D simulation to check if the features have been created correctly and to check for gouges.

- 1 Click Home tab > Simulation panel > Sim mode menu > 3D to change the simulation type.
- 2 Click **Play**  on the Simulation toolbar to start the simulation.
The 3D cutting simulation is displayed in the graphics window.



- 3 Click **Eject**  to end the simulation.

Autodesk Legal Notice

© 2017 Autodesk, Inc. All Rights Reserved. Except where otherwise noted, this work is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 3.0 Unported License that can be viewed online at <http://creativecommons.org/licenses/by-nc-sa/3.0/>. This license content, applicable as of 16 December 2014 to this software product, is reproduced here for offline users:

CREATIVE COMMONS CORPORATION IS NOT A LAW FIRM AND DOES NOT PROVIDE LEGAL SERVICES. DISTRIBUTION OF THIS LICENSE DOES NOT CREATE AN ATTORNEY-CLIENT RELATIONSHIP. CREATIVE COMMONS PROVIDES THIS INFORMATION ON AN "AS-IS" BASIS. CREATIVE COMMONS MAKES NO WARRANTIES REGARDING THE INFORMATION PROVIDED, AND DISCLAIMS LIABILITY FOR DAMAGES RESULTING FROM ITS USE.

License

THE WORK (AS DEFINED BELOW) IS PROVIDED UNDER THE TERMS OF THIS CREATIVE COMMONS PUBLIC LICENSE ("CCPL" OR "LICENSE"). THE WORK IS PROTECTED BY COPYRIGHT AND/OR OTHER APPLICABLE LAW. ANY USE OF THE WORK OTHER THAN AS AUTHORIZED UNDER THIS LICENSE OR COPYRIGHT LAW IS PROHIBITED.

BY EXERCISING ANY RIGHTS TO THE WORK PROVIDED HERE, YOU ACCEPT AND AGREE TO BE BOUND BY THE TERMS OF THIS LICENSE. TO THE EXTENT THIS LICENSE MAY BE CONSIDERED TO BE A CONTRACT, THE LICENSOR GRANTS YOU THE RIGHTS CONTAINED HERE IN CONSIDERATION OF YOUR ACCEPTANCE OF SUCH TERMS AND CONDITIONS.

1. Definitions

a. **"Adaptation"** means a work based upon the Work, or upon the Work and other pre-existing works, such as a translation, adaptation, derivative work, arrangement of music or other alterations of a literary or artistic work, or phonogram or performance and includes cinematographic adaptations or any other form in which the Work may be recast, transformed, or adapted including in any form recognizably derived from the original, except that a work that constitutes a Collection will not be considered an Adaptation for the purpose of this License. For the avoidance of doubt, where the Work is a musical work, performance or phonogram, the synchronization of the Work in timed-relation with a moving image ("synching") will be considered an Adaptation for the purpose of this License.

b. **"Collection"** means a collection of literary or artistic works, such as encyclopedias and anthologies, or performances, phonograms or broadcasts, or other works or subject matter other than works listed in Section 1(g) below, which, by reason of the selection and arrangement of their contents, constitute intellectual creations, in which the Work is included in its entirety in unmodified form along with one or more other contributions, each constituting separate and independent works in themselves, which together are assembled into a collective whole. A work that constitutes a Collection will not be considered an Adaptation (as defined above) for the purposes of this License.

c. **"Distribute"** means to make available to the public the original and copies of the Work or Adaptation, as appropriate, through sale or other transfer of ownership.

d. **"License Elements"** means the following high-level license attributes as selected by Licensor and indicated in the title of this License: Attribution, Noncommercial, ShareAlike.

e. **"Licensor"** means the individual, individuals, entity or entities that offer(s) the Work under the terms of this License.

f. **"Original Author"** means, in the case of a literary or artistic work, the individual, individuals, entity or entities who created the Work or if no individual or entity can be identified, the publisher; and in addition (i) in the case of a performance the actors, singers, musicians, dancers, and other persons who act, sing, deliver, declaim, play in, interpret or otherwise perform literary or artistic works or expressions of folklore; (ii) in the case of a phonogram the producer being the person or legal entity who first fixes the sounds of a performance or other sounds; and, (iii) in the case of broadcasts, the organization that transmits the broadcast.

g. **"Work"** means the literary and/or artistic work offered under the terms of this License including without limitation any production in the literary, scientific and artistic domain, whatever may be the mode or form of its expression including digital form, such as a book, pamphlet and other writing; a lecture, address, sermon or other work of the same nature; a dramatic or dramatico-musical work; a choreographic work or entertainment in dumb show; a musical composition with or without words; a cinematographic work to which are assimilated works expressed by a process analogous to cinematography; a work of drawing, painting, architecture, sculpture, engraving or lithography; a photographic work to which are assimilated works expressed by a process analogous to photography; a work of applied art; an illustration, map, plan, sketch or three-dimensional work relative to geography, topography, architecture or science; a performance; a broadcast; a phonogram; a compilation of data to the extent it is protected as a copyrightable work; or a work performed by a variety or circus performer to the extent it is not otherwise considered a literary or artistic work.

h. **"You"** means an individual or entity exercising rights under this License who has not previously violated the terms of this License with respect to the Work, or who has received express permission from the Licensor to exercise rights under this License despite a previous violation.

i. **"Publicly Perform"** means to perform public recitations of the Work and to communicate to the public those public recitations, by any means or process, including by wire or wireless means or public digital performances; to make available to the public Works in such a way that members of the public may access these Works from a place and at a place individually chosen by them; to perform the Work to the public by any means or process and the communication to the public of the performances of the Work, including by public digital performance; to broadcast and rebroadcast the Work by any means including signs, sounds or images.

j. **"Reproduce"** means to make copies of the Work by any means including without limitation by sound or visual recordings and the right of fixation and reproducing fixations of the Work, including storage of a protected performance or phonogram in digital form or other electronic medium.

2. Fair Dealing Rights. Nothing in this License is intended to reduce, limit, or restrict any uses free from copyright or rights arising from limitations or exceptions that are provided for in connection with the copyright protection under copyright law or other applicable laws.

3. License Grant. Subject to the terms and conditions of this License, Licensor hereby grants You a worldwide, royalty-free, non-exclusive, perpetual (for the duration of the applicable copyright) license to exercise the rights in the Work as stated below:

- a. to Reproduce the Work, to incorporate the Work into one or more Collections, and to Reproduce the Work as incorporated in the Collections;
- b. to create and Reproduce Adaptations provided that any such Adaptation, including any translation in any medium, takes reasonable steps to clearly label, demarcate or otherwise identify that changes were made to the original Work. For example, a translation could be marked "The original work was translated from English to Spanish," or a modification could indicate "The original work has been modified.";
- c. to Distribute and Publicly Perform the Work including as incorporated in Collections; and,
- d. to Distribute and Publicly Perform Adaptations.

The above rights may be exercised in all media and formats whether now known or hereafter devised. The above rights include the right to make such modifications as are technically necessary to exercise the rights in other media and formats. Subject to Section 8(f), all rights not expressly granted by Licensor are hereby reserved, including but not limited to the rights described in Section 4(e).

4. Restrictions. The license granted in Section 3 above is expressly made subject to and limited by the following restrictions:

a. You may Distribute or Publicly Perform the Work only under the terms of this License. You must include a copy of, or the Uniform Resource Identifier (URI) for, this License with every copy of the Work You Distribute or Publicly Perform. You may not offer or impose any terms on the Work that restrict the terms of this License or the ability of the recipient of the Work to exercise the rights granted to that recipient under the terms of the License. You may not sublicense the Work. You must keep intact all notices that refer to this License and to the disclaimer of warranties with every copy of the Work You Distribute or Publicly Perform. When You Distribute or Publicly Perform the Work, You may not impose any effective technological measures on the Work that restrict the ability of a recipient of the Work from You to exercise the rights granted to that recipient under the terms of the License. This Section 4(a) applies to the Work as incorporated in a Collection, but this does not require the Collection apart from the Work itself to be made subject to the terms of this License. If You create a Collection, upon notice from any Licensor You must, to the extent practicable, remove from the Collection any credit as required by Section 4(d), as requested. If You create an Adaptation, upon notice from any Licensor You must, to the extent practicable, remove from the Adaptation any credit as required by Section 4(d), as requested.

b. You may Distribute or Publicly Perform an Adaptation only under: (i) the terms of this License; (ii) a later version of this License with the same License Elements as this License; (iii) a Creative Commons jurisdiction license (either this or a later license version) that contains the same License Elements as this License (e.g., Attribution-NonCommercial-ShareAlike 3.0 US) ("Applicable License"). You must include a copy of, or the URI, for Applicable License with every copy of each Adaptation You Distribute or Publicly Perform. You may not offer or impose any terms on the Adaptation that restrict the terms of the Applicable License or the ability of the recipient of the Adaptation to exercise the rights granted to that recipient under the terms of the Applicable License. You must keep intact all notices that refer to the Applicable License and to the disclaimer of warranties with every copy of the Work as included in the Adaptation You Distribute or Publicly Perform. When You Distribute or Publicly Perform the Adaptation, You may not impose any effective technological measures on the Adaptation that restrict the ability of a recipient of the Adaptation from You to exercise the rights granted to that recipient under the terms of the Applicable License. This Section 4(b) applies to the Adaptation as incorporated in a Collection, but this does not require the Collection apart from the Adaptation itself to be made subject to the terms of the Applicable License.

c. You may not exercise any of the rights granted to You in Section 3 above in any manner that is primarily intended for or directed toward commercial advantage or private monetary compensation. The exchange of the Work for other copyrighted works by means of digital file-sharing or otherwise shall not be considered to be intended for or directed toward commercial advantage or private monetary compensation, provided there is no payment of any monetary compensation in connection with the exchange of copyrighted works.

d. If You Distribute, or Publicly Perform the Work or any Adaptations or Collections, You must, unless a request has been made pursuant to Section 4(a), keep intact all copyright notices for the Work and provide, reasonable to the medium or means You are utilizing: (i) the name of the Original Author (or pseudonym, if applicable) if supplied, and/or if the Original Author and/or Licensor designate another party or parties (e.g., a sponsor institute, publishing entity, journal) for attribution ("Attribution Parties") in Licensor's copyright notice, terms of service or by other reasonable means, the name of such party or parties; (ii) the title of the Work if supplied; (iii) to the extent reasonably practicable, the URI, if any, that Licensor specifies to be associated with the Work, unless such URI does not refer to the copyright notice or licensing information for the Work; and, (iv) consistent with Section 3(b), in the case of an Adaptation, a credit identifying the use of the Work in the Adaptation (e.g., "French translation of the Work by Original Author," or "Screenplay based on original Work by Original Author"). The credit required by this Section 4(d) may be implemented in any reasonable manner; provided, however, that in the case of a Adaptation or Collection, at a minimum such credit will appear, if a credit for all contributing authors of the Adaptation or Collection appears, then as part of these credits and in a manner at least as prominent as the credits for the other contributing authors. For the avoidance of doubt, You may only use the credit required by this Section for the purpose of attribution in the manner set out above and, by exercising Your rights under this License, You may not implicitly or explicitly assert or imply any connection with, sponsorship or endorsement by the Original Author, Licensor and/or Attribution Parties, as appropriate, of You or Your use of the Work, without the separate, express prior written permission of the Original Author, Licensor and/or Attribution Parties.

e. For the avoidance of doubt:

- i. Non-waivable Compulsory License Schemes. In those jurisdictions in which the right to collect royalties through any statutory or compulsory licensing scheme cannot be waived, the Licensor reserves the exclusive right to collect such royalties for any exercise by You of the rights granted under this License;
- ii. Waivable Compulsory License Schemes. In those jurisdictions in which the right to collect royalties through any statutory or compulsory licensing scheme can be waived, the Licensor reserves the exclusive right to collect such royalties for any exercise by You of the rights granted under this License if Your exercise of such rights is for a purpose or use which is otherwise than noncommercial as permitted under Section 4(c) and otherwise waives the right to collect royalties through any statutory or compulsory licensing scheme; and,
- iii. Voluntary License Schemes. The Licensor reserves the right to collect royalties, whether individually or, in the event that the Licensor is a member of a collecting society that administers voluntary licensing schemes, via that society, from any exercise by You of the rights granted under this License that is for a purpose or use which is otherwise than noncommercial as permitted under Section 4(c).

f. Except as otherwise agreed in writing by the Licensor or as may be otherwise permitted by applicable law, if You Reproduce, Distribute or Publicly Perform the Work either by itself or as part of any Adaptations or Collections, You must not distort, mutilate, modify or take other derogatory action in relation to the Work which would be prejudicial to the Original Author's honor or reputation. Licensor agrees that in those jurisdictions (e.g. Japan), in which any exercise of the right granted in Section 3(b) of this License (the right to make Adaptations) would be deemed to be a distortion, mutilation, modification or other derogatory action prejudicial to the Original Author's honor and reputation, the Licensor will waive or not assert, as appropriate, this Section, to the fullest extent permitted by the applicable national law, to enable You to reasonably exercise Your right under Section 3(b) of this License (right to make Adaptations) but not otherwise.

5. Representations, Warranties and Disclaimer

UNLESS OTHERWISE MUTUALLY AGREED TO BY THE PARTIES IN WRITING AND TO THE FULLEST EXTENT PERMITTED BY APPLICABLE LAW, LICENSOR OFFERS THE WORK AS-IS AND MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND CONCERNING THE WORK, EXPRESS, IMPLIED, STATUTORY OR OTHERWISE, INCLUDING, WITHOUT LIMITATION, WARRANTIES OF TITLE, MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, NONINFRINGEMENT, OR THE ABSENCE OF LATENT OR OTHER DEFECTS, ACCURACY, OR THE PRESENCE OF ABSENCE OF ERRORS, WHETHER OR NOT DISCOVERABLE. SOME JURISDICTIONS DO NOT ALLOW THE EXCLUSION OF IMPLIED WARRANTIES, SO THIS EXCLUSION MAY NOT APPLY TO YOU.

6. Limitation on Liability. EXCEPT TO THE EXTENT REQUIRED BY APPLICABLE LAW, IN NO EVENT WILL LICENSOR BE LIABLE TO YOU ON ANY LEGAL THEORY FOR ANY SPECIAL, INCIDENTAL, CONSEQUENTIAL, PUNITIVE OR EXEMPLARY DAMAGES ARISING OUT OF THIS LICENSE OR THE USE OF THE WORK, EVEN IF LICENSOR HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

7. Termination

- a. This License and the rights granted hereunder will terminate automatically upon any breach by You of the terms of this License. Individuals or entities who have received Adaptations or Collections from You under this License, however, will not have their licenses terminated provided such individuals or entities remain in full compliance with those licenses. Sections 1, 2, 5, 6, 7, and 8 will survive any termination of this License.
- b. Subject to the above terms and conditions, the license granted here is perpetual (for the duration of the applicable copyright in the Work). Notwithstanding the above, Licensor reserves the right to release the Work under different license terms or to stop distributing the Work at any time; provided, however that any such election will not serve to withdraw this License (or any other license that has been, or is required to be, granted under the terms of this License), and this License will continue in full force and effect unless terminated as stated above.

8. Miscellaneous

- a. Each time You Distribute or Publicly Perform the Work or a Collection, the Licensor offers to the recipient a license to the Work on the same terms and conditions as the license granted to You under this License.
- b. Each time You Distribute or Publicly Perform an Adaptation, Licensor offers to the recipient a license to the original Work on the same terms and conditions as the license granted to You under this License.
- c. If any provision of this License is invalid or unenforceable under applicable law, it shall not affect the validity or enforceability of the remainder of the terms of this License, and without further action by the parties to this agreement, such provision shall be reformed to the minimum extent necessary to make such provision valid and enforceable.
- d. No term or provision of this License shall be deemed waived and no breach consented to unless such waiver or consent shall be in writing and signed by the party to be charged with such waiver or consent.
- e. This License constitutes the entire agreement between the parties with respect to the Work licensed here. There are no understandings, agreements or representations with respect to the Work not specified here. Licensor shall not be bound by any additional provisions that may appear in any communication from You. This License may not be modified without the mutual written agreement of the Licensor and You.
- f. The rights granted under, and the subject matter referenced, in this License were drafted utilizing the terminology of the Berne Convention for the Protection of Literary and Artistic Works (as amended on September 28, 1979), the Rome Convention of 1961, the WIPO Copyright Treaty of 1996, the WIPO Performances and Phonograms Treaty of 1996 and the Universal Copyright Convention (as revised on July 24, 1971). These rights and subject matter take effect in the relevant jurisdiction in which the License terms are sought to be enforced according to the corresponding provisions of the implementation of those treaty provisions in the applicable national law. If the standard suite of rights granted under applicable copyright law includes additional rights not granted under this License, such additional rights are deemed to be included in the License; this License is not intended to restrict the license of any rights under applicable law.

Creative Commons Notice

Creative Commons is not a party to this License, and makes no warranty whatsoever in connection with the Work. Creative Commons will not be liable to You or any party on any legal theory for any damages whatsoever, including without limitation any general, special, incidental or consequential damages arising in connection to this license. Notwithstanding the foregoing two (2) sentences, if Creative Commons has expressly identified itself as the Licensor hereunder, it shall have all rights and obligations of Licensor.

Except for the limited purpose of indicating to the public that the Work is licensed under the CCPL, Creative Commons does not authorize the use by either party of the trademark "Creative Commons" or any related trademark or logo of Creative Commons without the prior written consent of Creative Commons. Any permitted use will be in compliance with Creative Commons' then-current trademark usage guidelines, as may be published on its website or otherwise made available upon request from time to time. For the avoidance of doubt, this trademark restriction does not form part of this License.

Creative Commons may be contacted at <http://creativecommons.org/>.

Certain materials included in this publication are reprinted with the permission of the copyright holder.

Creative Commons FAQ

Autodesk's Creative Commons FAQ can be viewed online at <http://www.autodesk.com/company/creative-commons>, and is reproduced here for offline users.

In collaboration with Creative Commons, Autodesk invites you to share your knowledge with the rest of the world, inspiring others to learn, achieve goals, and ignite creativity. You can freely borrow from the Autodesk Help, Support and Video libraries to build a new learning experience for anyone with a particular need or interest.

What is Creative Commons?

Creative Commons (CC) is a nonprofit organization that offers a simple licensing model that frees digital content to enable anyone to modify, remix, and share creative works.

How do I know if Autodesk learning content and Autodesk University content is available under Creative Commons?

All Autodesk learning content and Autodesk University content released under Creative Commons is explicitly marked with a Creative Commons icon specifying what you can and cannot do. Always follow the terms of the stated license.

What Autodesk learning content is currently available under Creative Commons?

Over time, Autodesk will release more and more learning content under the Creative Commons licenses.

Currently available learning content:

- Autodesk online help-Online help for many Autodesk products, including its embedded media such as images and help movies.
- Autodesk Learning Videos-A range of video-based learning content, including the video tutorials on the Autodesk YouTube™ Learning Channels and their associated iTunes® podcasts.
- Autodesk downloadable materials-Downloadable 3D assets, digital footage, and other files you can use to follow along on your own time.

Is Autodesk learning and support content copyrighted?

Yes. Creative Commons licensing does not replace copyright. Copyright remains with Autodesk or its suppliers, as applicable. But it makes the terms of use much more flexible.

What do the Autodesk Creative Commons licenses allow?

Autodesk makes some of its learning and support content available under two distinct Creative Commons licenses. The learning content is clearly marked with the applicable Creative Commons license. You must comply with the following conditions:

- **Attribution-NonCommercial-ShareAlike (CC BY-NC-SA)** This license lets you copy, distribute, display, remix, tweak, and build upon our work noncommercially, as long as you credit Autodesk and license your new creations under the identical terms.
- **Attribution-NonCommercial-No Derivative Works (CC BY-NC-ND)** This license lets you copy, distribute, and display only verbatim copies of our work as long as you credit us, but you cannot alter the learning content in any way or use it commercially.
- **Special permissions on content marked as No Derivative Works** For video-based learning content marked as No Derivative Works (ND), Autodesk grants you special permission to make modifications but only for the purpose of translating the video content into another language.

These conditions can be modified only by explicit permission of Autodesk, Inc. Send requests for modifications outside of these license terms to creativecommons@autodesk.com.

Can I get special permission to do something different with the learning content?

Unless otherwise stated, our Creative Commons conditions can be modified only by explicit permission of Autodesk, Inc. If you have any questions or requests for modifications outside of these license terms, email us at creativecommons@autodesk.com.

How do I attribute Autodesk learning content?

You must explicitly credit Autodesk, Inc., as the original source of the materials. This is a standard requirement of the Attribution (BY) term in all Creative Commons licenses. In some cases, such as for the Autodesk video learning content, we specify exactly how we would like to be attributed.

This is usually described on the video's end-plate. For the most part providing the title of the work, the URL where the work is hosted, and a credit to Autodesk, Inc., is quite acceptable. Also, remember to keep intact any copyright notice associated with the work. This may sound like a lot of information, but there is flexibility in the way you present it.

Here are some examples:

"This document contains content adapted from the Autodesk® Maya® Help, available under a Creative Commons Attribution-NonCommercial-Share Alike license. Copyright © Autodesk, Inc."

"This is a Finnish translation of a video created by the Autodesk Maya Learning Channel @ www.youtube.com/mayahowtos. Copyright © Autodesk, Inc."

"Special thanks to the Autodesk® 3ds Max® Learning Channel @ www.youtube.com/3dsmaxhowtos. Copyright © Autodesk, Inc."

Do I follow YouTube's standard license or Autodesk's Creative Commons license?

The videos of the Autodesk Learning Channels on YouTube are uploaded under YouTube's standard license policy. Nonetheless, these videos are released by Autodesk as Creative Commons Attribution-NonCommercial-No Derivative Works (CC BY-NC-ND) and are marked as such.

You are free to use our video learning content according to the Creative Commons license under which they are released.

Where can I easily download Autodesk learning videos?

Most of the Autodesk Learning Channels have an associated iTunes podcast from where you can download the same videos and watch them offline. When translating Autodesk learning videos, we recommend downloading the videos from the iTunes podcasts.

Can I translate Autodesk learning videos?

Yes. Even though our learning videos are licensed as No Derivative Works (ND), we grant everyone permission to translate the audio and subtitles into other languages. In fact, if you want to recapture the video tutorial as-is but show the user interface in another language, you are free to do so. Be sure to give proper attribution as indicated on the video's Creative Commons end-plate. This special permission only applies to translation projects. Requests for modifications outside of these license terms can be directed to creativecommons@autodesk.com.

How do I let others know that I have translated Autodesk learning content into another language?

Autodesk is happy to see its learning content translated into as many different languages as possible. If you translate our videos or any of our learning content into other languages, let us know. We can help promote your contributions to our growing multilingual community. In fact, we encourage you to find creative ways to share our learning content with your friends, family, students, colleagues, and communities around the world. Contact us at creativecommons@autodesk.com.

I have translated Autodesk learning videos into other languages. Can I upload them to my own YouTube channel?

Yes, please do and let us know where to find them so that we can help promote your contributions to our growing multilingual Autodesk community. Contact us at creativecommons@autodesk.com.

Can I repost or republish Autodesk learning content on my site or blog?

Yes, you can make Autodesk learning material available on your site or blog as long as you follow the terms of the Creative Commons license under which the learning content is released. If you are simply referencing the learning content as-is, then we recommend that you link to it or embed it from where it is hosted by Autodesk. That way the content will always be fresh. If you have translated or remixed our learning content, then by all means you can host it yourself. Let us know about it, and we can help promote your contributions to our global learning community. Contact us at creativecommons@autodesk.com.

Can I show Autodesk learning content during my conference?

Yes, as long as it's within the scope of a noncommercial event, and as long as you comply with the terms of the Creative Commons license outlined above. In particular, the videos must be shown unedited with the exception of modifications for the purpose of translation. If you wish to use Autodesk learning content in a commercial context, contact us with a request for permission at creativecommons@autodesk.com.

Can I use Autodesk learning content in my classroom?

Yes, as long as you comply with the terms of the Creative Commons license under which the learning material is released. Many teachers use Autodesk learning content to stimulate discussions with students or to complement course materials, and we encourage you to do so as well.

Can I re-edit and remix Autodesk video learning content?

No, but for one exception. Our Creative Commons BY-NC-ND license clearly states that "derivative works" of any kind (edits, cuts, remixes, mashups, and so on) are not allowed without explicit permission from Autodesk. This is essential for preserving the integrity of our instructors' ideas. However, we do give you permission to modify our videos for the purpose of translating them into other languages.

Can I re-edit and remix Autodesk downloadable 3D assets and footage?

Yes. The Autodesk Learning Channels on YouTube provide downloadable 3D assets, footage, and other files for you to follow along with the video tutorials on your own time. This downloadable material is made available under a Creative Commons Attribution-NonCommercial-ShareAlike (CC BY-NC-SA) license. You can download these materials and experiment with them, but your remixes must give us credit as the original source of the content and be shared under the identical license terms.

Can I use content from Autodesk online help to create new materials for a specific audience?

Yes, if you want to help a specific audience learn how to optimize the use of their Autodesk software, there is no need to start from scratch. You can use, remix, or enrich the relevant help content and include it in your book, instructions, examples, or workflows you create, then Share-Alike with the community. Always be sure to comply with the terms of the Creative Commons license under which the learning content is released.

What are the best practices for marking content with Creative Commons Licenses?

When reusing a CC-licensed work (by sharing the original or a derivative based on the original), it is important to keep intact any copyright notice associated with the work, including the Creative Commons license being used. Make sure you abide by the license conditions provided by the licensor, in this case Autodesk, Inc.

Trademarks

The following are registered trademarks or trademarks of Autodesk, Inc., and/or its subsidiaries and/or affiliates in the USA and other countries: 123D, 3ds Max, Alias, ATC, AutoCAD LT, AutoCAD, Autodesk, the Autodesk logo, Autodesk 123D, Autodesk Homestyler, Autodesk Inventor, AutoSnap, BIM 360, Buzzsaw, CADmep, CAMduct, Civil 3D, Configurator 360, Dancing Baby (image), DWF, DWG, DWG (design/logo), DWG Extreme, DWG TrueConvert, DWG TrueView, DWGX, DXF, Ember, ESTmep, FBX, Flame, FormIt 360, Fusion 360, Glue, Heidi, Homestyler, InfraWorks, Instructables, Instructables (stylized robot design/logo), Inventor, Inventor HSM, Inventor LT, Maya, Maya LT, Moldflow Plastics Advisers, Moldflow, MotionBuilder, Mudbox, Navisworks, Opticore, P9, Pier 9, Pixlr, Pixlr-o-matic, Publisher 360, RasterDWG, RealDWG, ReCap, ReCap 360, Remote, Revit LT, Revit, Scaleform, Showcase, Showcase 360, SketchBook, Softimage, Spark & Design, Spark Logo, Tinkercad, Tinkerplay, TrustedDWG, VRED

All other brand names, product names or trademarks belong to their respective holders.

Disclaimer

THIS PUBLICATION AND THE INFORMATION CONTAINED HEREIN IS MADE AVAILABLE BY AUTODESK, INC. "AS IS." AUTODESK, INC. DISCLAIMS ALL WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE REGARDING THESE MATERIALS.



Except where otherwise noted, this work is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 3.0 Unported License. Please see the Autodesk Creative Commons FAQ for more information.

Index

2

2.5D milling • 6
2D turned profile • 23, 37, 38

3

3D milling • 45
3D toolpath simulation • 9, 29, 44, 54, 57

A

Arc • 46
Area clearance
 Roughing • 53
Assistance bar • 4
Automatic ordering • 12, 30

B

Bore feature • 23

C

Centre all • 20, 35
Chain curves • 21, 35, 46
Chamfer • 21
Checklist • 15
Controlling operations • 15
Controlling strategies • 15
Coordinate system • 20, 35
Curve • 21, 35, 41, 56
 Arc • 46
 Profile • 56

Cutoff feature • 23

D

Database • 2
 Material database • 2
 Tool database • 2
Display mode toolbar • 23
 2D turned profile • 23, 37, 38
Draft angle • 60
Duplicate holes • 39

E

Engraving • 41

F

Face feature • 23
Feature
 Bore feature • 23
 Cutoff feature • 23
 Duplicate holes • 39
 Engraving • 41
 Face feature • 23
 Groove feature • 23
 Hole feature • 7, 23, 39
 Pocket feature • 7
 Slot feature • 43
 Surface milling feature • 53
 Thread feature • 23
 Turn feature • 23, 37
 Wire EDM feature • 56
Feature/geometry edit bar • 4
Fillet • 35

Finishing • 53
Front view • 9

G

Geometry
 Hide all geometry • 51
 Show all surfaces • 51
Geometry creation • 21, 46
 Arc • 46
 Chain curves • 21, 35, 46
 Chamfer • 21
 Curve • 21, 35, 41, 56
 Draft angle • 60
 Engraving • 41
 Fillet • 35
 Line • 21, 35, 46
 Profile • 56
 Taper • 60
 Text • 41
Geometry edit bar • 4
Graphics window • 4
 Results window • 4, 11, 12, 13, 15, 30, 32
 Toolbox window • 4
Groove feature • 23

H

Hide all geometry • 51
Hole feature • 7, 23, 39

I

Imperial tools • 2
Imperial units • 4
Inch tools • 2
Inch units • 4
Input modes • 20, 35
Isometric view • 9, 27, 38, 51

L

Line • 21, 35, 46

M

Machining operations • 11, 30

Automatic ordering • 12, 30
Controlling operations • 15
Controlling strategies • 15
Finishing • 53
Manual ordering • 13
Operation template • 30
Ordering options • 12, 30
Results window • 4, 11, 12, 13, 15, 30, 32
Roughing • 53
Semi-finishing • 53
Manual ordering • 13
Manufacturing
 NC code • 16, 33, 59
 Post processor • 17
Manufacturing operations • 11, 30
 Automatic ordering • 12, 30
 Controlling operations • 15
 Controlling strategies • 15
 Finishing • 53
 Manual ordering • 13
 Operation template • 30
 Ordering options • 12, 30
 Results window • 4, 11, 12, 13, 15, 30, 32
 Roughing • 53
 Semi-finishing • 53
Material database • 2
Menu bar • 4
Metric tools • 2
Metric units • 4
Mill/turn • 34
Milling
 2.5D milling • 6
 3D milling • 45
 Surface milling feature • 53
Milling setup • 4

N

NC code • 16, 33, 59
 Saving NC code • 17
 Tool mapping • 17

O

Opening a part • 4
Operation template • 30
Operations • 11, 30

- Automatic ordering • 12, 30
- Controlling operations • 15
- Controlling strategies • 15
- Manual ordering • 13
- Operation template • 30
- Ordering options • 12, 30
- Operations list • 15
- Operator's checklist • 15
- Ordering of operations • 11, 30
 - Automatic ordering • 12, 30
 - Controlling operations • 15
 - Controlling strategies • 15
 - Manual ordering • 13
 - Operation template • 30
 - Ordering options • 12, 30
- Ordering options • 12, 30

P

- Part
 - Opening a part • 4
- Part documentation • 15, 32
- Pocket feature • 7
- Post processor • 17
- Profile • 56

R

- Results window • 4, 11, 12, 13, 15, 30, 32
- Roughing • 53

S

- Saving NC code • 17
- Screen layout • 4
- Semi-finishing • 53
- Setup
 - Imperial units • 4
 - Inch units • 4
 - Metric units • 4
 - Milling setup • 4
- Shading • 27, 38, 51
- Show all surfaces • 51
- Simulating toolpaths • 9, 29, 44, 54, 57
 - 3D toolpath simulation • 9, 29, 44, 54, 57
- Slot feature • 43
- Starting FeatureCAM • 2

- Status bar • 4
- Stock • 6, 19, 35, 46, 55
- Strategy
 - Automatic ordering • 12, 30
 - Controlling strategies • 15
 - Manual ordering • 13
 - Ordering of operations • 11, 30
 - Ordering options • 12, 30
- Surface creation • 50
 - Surface of revolution • 50
- Surface milling feature • 53
- Surface of revolution • 50

T

- Taper • 60
- Template
 - Operation template • 30
- Text • 41
- Thread feature • 23
- Title bar • 4
- Tool database • 2
 - Imperial tools • 2
 - Inch tools • 2
 - Metric tools • 2
- Tool mapping • 17
- Toolbars • 4
 - Assistance bar • 4
 - Display mode toolbar • 23
 - Feature/geometry edit bar • 4
 - Geometry edit bar • 4
 - Menu bar • 4
 - Status bar • 4
 - Title bar • 4
- Toolbox window • 4
- Toolpath
 - Simulating toolpaths • 9, 29, 44, 54, 57
- Tools
 - Imperial tools • 2
 - Inch tools • 2
 - Metric tools • 2
 - Tool database • 2
 - Tool mapping • 17
- Tools list • 15
- Turn feature • 23, 37
- Turn/mill • 34
- Turning • 19

U

Units

- Imperial tools • 2
- Imperial units • 4
- Inch tools • 2
- Inch units • 4
- Metric tools • 2
- Metric units • 4

V

Viewing the part • 9, 27, 38, 51

- Hide all geometry • 51
- Shading • 27, 38, 51
- Show all surfaces • 51

Views

- 2D turned profile • 23, 37, 38
- Centre all • 20, 35
- Front view • 9
- Isometric view • 9, 27, 38, 51
- Viewing the part • 9, 27, 38, 51

W

Window

- Graphics window • 4
- Results window • 4, 11, 12, 13, 15, 30, 32
- Toolbox window • 4

Wire EDM • 55

Wire EDM feature • 56